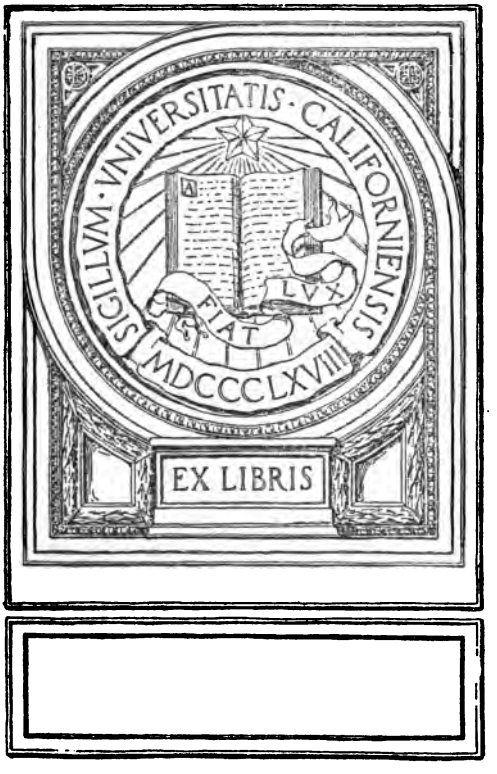
Practical Track Maintenance

By KENNETH L. VAN AUKEN



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(Second Edition)

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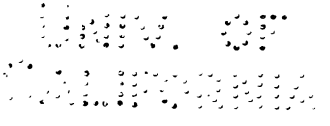
By Kenneth L. Van Auken

(Author of PRACTICAL TRACK WORK)



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FOREWORD.

The author realizes that track maintenance, in all its phases, is an immense subject; and the problem of writing a book with this title proved to be a pruning and refining process—the exercise of judgment as to what might be left out, rather than what might be put in. The information which was considered absolutely essential was that which the trackman can use in his every day work.

The author originally had in mind, and the finished book is now intended mainly as, a treatment of routine section work only; an outline was worked up which was submitted to a number of trackmen of wide practical experience, who are also writers, and who have contributed much of value from their own experience for the benefit of trackmen. The suggestions received from these practical track men resulted in a partial rearrangement and amplification of the chapter subjects. The manuscript was then written and submitted for detailed criticisms and suggestions, to the following men: Charles L. Van Auken; F. R. Layng, engineer of track, Bessemer & Lake Erie R. R.; S. J. Evans, general foreman, Central California Traction Co.; J. J. Hess, assistant engineer maintenance of way, Great Northern Ry.; J. W. Powers, supervisor of track, New York Central R. R., and D. O'Hern, supervisor, Elgin, Joliet & Eastern R. R.

The author does not claim complete originality for all the material in the book—rather he disclaims it. He does claim, however, to have combined the results of his own experience with a digest of the opinions of trackmen, and

to have formulated the conclusions and suggestions given. The men mentioned above are located in various parts of the country,—north, east, south and west—and it is thought, therefore, that the general conditions over the entire country have been covered. The author hopes that in accepting the suggestions which have been offered him, that the book has been broadened far beyond one man's viewpoint.

Information has been used freely from articles published in the proceedings and bulletins of both the Roadmasters' and Maintenance of Way Association and the American Railway Engineering Association. The files of the Railway Age Gazette and the Railway Review also have been freely consulted, and the information obtained proved of much benefit in the preparation of the manuscript. Parts of the completed book have appeared in each of the above publications as contributed articles under the author's name, in which case no direct credit has been given herein, the matter simply having been published by these papers preliminary to its appearing in book form. Wherever information has been taken verbatim from any paper, which was not originally published under the author's name, credit has been given in the text.

The author will be pleased to receive suggestions or criticisms from any trackmen who read the book, as revisions are to be made from time to time.

K. L. V.

April 1, 1916

SECOND EDITION

The constantly growing demand for this book and the complimentary comments received on it have pleased the Author more than the gradual but constant increase in the demand.

The second edition is issued in the hope that many others will benefit, and doing so will speak a good word for the book to others.

February 1, 1921 K. L. V.

CHAPTER I.

THE BIG PROBLEM—LABOR.

The ultimate object of maintenance is to provide track over which traffic may be handled safely, expeditiously and economically. Two ingredients go into track maintenance—material and labor. The necessity for having the best materials is not to be minimized and the track and purchasing departments should co-operate with this end in view. The financial condition of the road must of course be taken into account when buying materials, including tools, but it will always be found profitable to keep service records and to consider the ultimate cost rather than the first cost. The practice of allowing the purchasing agent to buy tools wholly on price should be discouraged and the track foreman should be consulted as to the most economical makes to use.

One foreman reports that with a good claw bar, one man alone will pull twice as many spikes as two men with a poor claw bar and hammer. The first cost of the good claw bar is only $2.00 per dozen more than the other and four times as much work is obtained per man with it. This results in a saving in 10 hours constant use of $5.25 (labor at $1.75) since it would require four men to do as much work; and the investment in tools is greater with the poor claw bar because two tools must be provided to obtain the same capacity. It is a notable fact that the average laborer is far more careful of a good tool than of a poor one. It seems ad-

visable, therefore, to economize rather in the number of tools purchased than to sacrifice quality.

The increase in wages which would be necessary to obtain a higher grade of labor in track work is evidently thought out of proportion to the benefits to be derived. This is partly because it is impossible to perform permanent repair work advantageously during the entire year. Furthermore, the enforced demands of employes of other departments have cut into revenue so deeply that railways claim they have been unable to raise the wages of track laborers materially.

In any field of labor the ability to secure workmen is dependent upon many circumstances, among which are conditions of work, pay for labor performed, and the possibility of promotion—or at least the prospects of making more than a bare livelihood. Other influences are the conditions of the labor market, both general and local, the cost of living and the tendencies of the community.

In the last 15 years the average rate paid trackmen has increased hardly more than 15 cents per day, during which time wages of labor in other industries has increased probably an average of $1.00 per day.

Trackmen generally feel that wages are too low. One supervisor predicts that a 25 per cent increase in wages would give a 100 per cent increase in the amount of work turned out. Other railway labor has received an advance aggregating close to 50 per cent, while the trackmen's increase is only about 8 1/3 per cent. This has resulted in track gangs becoming training schools for other industries and particularly for contractors.

It is a fact to be deplored that railways in general

could not or would not voluntarily increase the wages of track labor when the wages of other classes of employes were raised. This policy could have been made a strong argument in arbitrations for scaling down the demands of the other employes.

Since the demand exceeded the supply of native laborers, many foreigners have emigrated to this country and the large percentage of trackmen are composed of these immigrants. The Roadmasters' & Maintenance of Way Association in a report submitted in 1912 said, "It is a grim fact that track labor has very materially deteriorated and that the cost of maintenance has gone up, while the efficiency has decreased. Men of a class such as formerly followed track work are no longer to be had. It is plainly evident therefore that we must depend almost entirely upon the foreigner for our source of labor supply for the present as well as for the future." This is true unless the wages of laborers are very materially increased; and even if they are increased, probably the majority of trackmen would still be foreigners, but they would be of a higher class, both physically and intellectually. Where contractors are paying 75 cents a day more for laborers, they have to turn applicants away, while railway section and extra gangs in the same vicinity are constantly short of men. Since railways must depend to a large extent on foreigners for trackmen, they should take steps to obtain the maximum results from this class. Many of them are intelligent and willing, and capable of making good trackmen, provided they can be interested in the work. To interest them it is necessary to educate them, or at least to furnish instruction in track work as well as to hold out the possibility of promotion as a reward for intelligent industry.

S. J. Evans, an extra gang and general track foreman of wide experience, states that he has developed many foreign foremen by putting those interested through a course of instruction in surfacing and lining, teaching them to read switch plans, etc. In other words, he treats his laborers as students in track work and thereby not only obtains more satisfactory work from them, but develops many of them into good foremen.

Interpreters—Trackmen generally know that the interpreter, in practically every case, is a positive hindrance rather than a help. While he makes profuse promises to obtain the best men and guarantees a fair day's work from them, he seldom keeps these promises. Since the commercial labor agency is frequently forced to hire interpreters in order to get the men to send out, many railways have come to consider the interpreter a necessary evil. By united action, however, it ought to be possible to eliminate the interpreter, and this would without question, result in an immediate increase in the efficiency of gangs of foreigners.

There is no objection to making a conscientious and ambitious foreigner, even an interpreter, an assistant foreman, especially if he is given to understand that increased ability will result either in increased pay or in preference when permanent positions are to be filled. As a representative of the company rather than a representative of the men, the interpreter is not likely to retain his old hold on them.

Trackmen Skilled Laborers—It is quite common for employes of other departments to deride the section forces. This is particularly true of the trainmen and is a much greater detriment to the discipline of track

forces than is generally realized. When using a work train, positive instructions should be issued to the conductor to report to the foreman, as only by this method can the foreman command the respect of the train crew. In this way the trainmen can be prevented from interfering or joshing with the men. Expert trackmen are skilled laborers and should be treated as such.

Some words on the status of the laborer by Thomas Cain, a foreman of the Michigan Central division of the New York Central, are especially apt in this connection. He says: "The principal element which gives to labor its dignity and ennobling quality is its voluntary character. The greater and more complete the independence of the worker, the greater the pleasure in his work and the more he will accomplish. Independence alone is one of the greatest incentives to offer laborers in order to get track work done. Give the laborer to understand that for his ability and earnest endeavors, he will be treated as an American citizen, and that no labor, no matter of what condition so long as it is honest, is degrading."

Obtaining Laborers—On many roads the section foreman hires all his men, and this is an excellent policy to follow wherever practicable. The best results can be obtained from local laborers and the authority of the foreman is better if he is allowed to hire his own men. Trouble is frequently experienced with foreigners hired by the roadmaster or by a commercial labor agency. Even if hired through a company labor bureau there may be trouble with these men unless the officers of the bureau are conscientious and working for the best interests of the company. It is not always possible, however, to obtain a sufficient number of section men locally,

and it then becomes necessary to hire foreigners or hobos to fill out the gangs.

In general, laborers hired through private labor agencies prove unsatisfactory. If necessary to hire men in this manner, every shipment should be inspected by a competent representative of the track department before being accepted. Instances have been known where officers specified that *all* laborers must be hired through one particular commercial labor agency. This arrangement, which smacks of collusion between the labor agency and the officers, often results in the poorest class of men being furnished. Forbidding a foreman or road-master to hire local men, or even to hire gangs for shipment from any agency where a good gang can be secured, is a detriment to the discipline of the road, a detriment to the amount of work accomplished, and, in the end, a detriment to the proper maintenance of track. The exclusive labor agency eliminates labor competition, making it possible to charge an exorbitant fee and the railway really has to pay for this because it obtains a poorer class of laborers—good laborers will not pay the exorbitant fees charged.

Company Labor Bureau—The maintenance of way department of the Baltimore & Ohio established a free labor bureau in August, 1912, with main office at Baltimore. Shortly afterwards small branch offices were established at other points. The original intention was to secure men for the maintenance of way department only. A short time later, however, the service of the bureau was extended to secure men for other branches of the service, but the bureau is still used principally to obtain trackmen.

In August, 1913, the labor bureau was put under the

jurisdiction of the bureau of employment and is no longer under the supervision of the maintenance of way department. Its affairs are administered by a chief labor agent at Baltimore. He has an office assistant, who also does scout work, and three assistants who travel from point to point where laborers are available. Attached to the bureau are men who act from time to time as pilots for large gangs. These men have had wide experience in this work and they keep in touch with available gangs.

Newspaper advertisements explain the requirements and acquaint the public with the location of the labor bureau offices, but in addition there is a man called a scout who distributes cards throughout the city, advertising the jobs for which men are sought. For all jobs except those on track, the applicants must fill out the standard application blanks, which are then investigated by the employment bureau, the men being taken on temporarily pending the outcome of the investigation. All men accepting employment must pass a physical examination.

Each man, when hired, is given a card which identifies him, the card having a number, stating the class of work the man is engaged for, the rate of pay, destination and approximate time of shipment. The pass issued for the man has a duplicate of the number on his card so that the conductor can identify the laborer. Pilots are sent with large gangs which are to be shipped a long distance, and also with gangs of foreigners, if they are unable to speak English. The conductor takes care of the men on short shipments.

Since the demand for laborers is great, there has been but little choice in the acceptance of men. The division

people call on the labor bureau frequently and favor the plan very much, but the most of the men sent out are for extra gangs for temporary work and they are laid off when the job is completed. The laborers favor the plan because no fee is charged. The labor bureau has not undertaken to better the conditions of supervision or living for the laborers, this being handled by the division people. Judging by the favor in which the labor bureau is held by the division officials and the laborers themselves, it is a distinct success.

OBTAINING LABORERS—PRESENT PRACTICE.

The usual method of obtaining laborers might be compared to the purchase of railway materials at a fixed price on specifications made up entirely by the manufacturer. This is ridiculous on the face of it. The primary value of a company labor bureau is simply that of organization—the delegation of the duties of hiring men to the head of the bureau who can then be held responsible for the men obtained. The labor bureau keeps in touch with local shortages and surpluses over the entire system and thus is able to ship from places where there is a surplus. Of course there are many small roads on which a labor bureau would not be justified, and some of the larger roads seem to be obtaining fair results under present methods.

The western lines of the Canadian Pacific Ry., comprising 7140 miles of single main track and 973 miles of double main track, have the divisional organization. The district superintendent is responsible for all maintenance of way work and the resident engineer, bridge and building master, roadmaster and signal supervisor on a district report to him.

The larger number of maintenance of way laborers are

foreigners—Galicians, Scandinavians, Italians and Russians. The rest of the laborers are Americans, Canadians, Scotchmen, Irishmen and Englishmen. Men are collected in such cities as Montreal, Winnipeg and Vancouver, through private labor agencies. The custom in busy seasons has been to ask the labor agency to supply a certain number of men for extra gang or track section work. These men are transported free to the point of work and are sent in charge of a constable, who remains in charge until the men are turned over to the roadmaster under whose direction they are to work The men's pay begins when they actually commence work.

The Chicago Milwaukee & St. Paul Ry. usually obtains its laborers in Chicago, although sometimes they are procured from Milwaukee, Minneapolis, St. Paul, Kansas City, Omaha, Sioux City, Des Moines, Cedar Rapids or various other large cities on the lines. These laborers are obtained through private labor agencies and are inspected before they are accepted and given transportation. No labor bureau is maintained. All matters pertaining to the work are handled through the office of the vice-president of operation and construction.

On the Chicago Great Western R. R. the maintenance of way laborers are obtained in Chicago, Des Moines, Kansas City and St. Paul through private labor agencies. The men furnished are usually inspected before being loaded into the cars at point of shipment. This system is not very large and the general manager, chief engineer and superintendents can all keep in touch with each supervisor and in a large measure with each section foreman. Under these conditions, present methods seem to be efficient.

Most of the track laborers on the Illinois Central R. R.

are obtained from Chicago, St. Louis, Louisville, Memphis and New Orleans, often through private labor agencies, although foremen generally hire their own men. Laborers furnished by private labor agencies are not inspected before being accepted.

On the Chicago & North Western Ry. most of the men are obtained locally. Where they cannot be obtained along the line of the road, they are shipped from such labor centers as Chicago, Milwaukee, Sioux City, Omaha, etc. Laborers are employed through licensed agencies, no company agencies being maintained. A regular inspector is not employed to accept the shipments, but frequent observations are made of the class of men being sent out.

The laborers on the lines of the Southern Pacific Co. are obtained from San Francisco, Oakland, Los Angeles, Portland, Sacramento and other large towns. Most of them are hired by direct application of the men themselves to the division engineers, roadmasters or superintendents. The principal exception to this is in the case of Mexican labor used in Southern California, Arizona and New Mexico, these laborers being hired through a delegated representative established for the purpose. An employe of the company is delegated to the agency to inspect and accept shipments.

HOLDING LABORERS.

Humanitarian principles demand that laborers be accorded all possible advantages and conveniences. If men are to be retained in track work, which is greatly to be desired, it is absolutely necessary to look after their welfare. We believe that laborers should be assured: (1) Permanent or year around work. (2) Sanitary, comfortable habitations. (3) Good food. (4) Considerate treatment. (5) The possibility of promotion. (6) In-

struction in track work. (7) Free transportation. (8) Pensions. (9) Motor cars. (10) Labor saving tools. (11) Increase in wages, depending on increase in amount of work done and length of service. The faithfulness of section men is proverbial and even under the most careless treatment the section forces in emergencies respond freely to the great demands upon their energy. This loyalty could be greatly augmented by the officials working for an improvement in conditions.

(1) **Year Around Work**—So deeply rooted is the present system of increasing and decreasing forces that it will require strong and convincing proof of economy to change the practice. It requires more time to do poor work with inexperienced men than to do good work with experienced men. It is not to be expected that railways can retain men in their employ when they cannot be worked to advantage, but it is the policy of wisdom and economy to reduce forces more judiciously and to retain more men permanently.

The Long Island R. R. in 1912 adopted the system of employing men permanently. This road has a sandy subsoil which does not freeze very deeply in the winter time and there is very little track heaving. Five laborers are allowed to each section the year around, whereas formerly the forces fluctuated with a maximum of eight laborers. At the time of the change the pay of the track laborers as well as the foreman and assistant foreman was raised. The men are assured permanent employment as long as their work is satisfactory, although in the winter time the forces work only 9 hours per day.

The extra gangs have been decreased to five of ten men each. The total number of men was reduced sufficiently to make the year's pay roll the same as it was

previously and the allowance is now one man to 1.6 miles of main line track. This change has resulted in an increase in efficiency of about 35 per cent. About 50 per cent of the old employes have been replaced with more efficient men and there are many applications on file from good men for positions as laborer and also for positions as foreman. In 1913, 37.5 more ties were put in than in 1912, the cost for labor and supervision being exactly the same. The personal injuries have been greatly decreased on account of having more intelligent and experienced men on the work.

(2) **Sanitary Housing**—Some trackman is authority for the statement that the quarters furnished many track laborers would be shunned by a high breed of pigs. It is only recently that this subject has attracted the attention it deserves. Where bunk cars or section houses are provided, an effort should be made not only to make them durable, but to make them pleasant to live in. Some of the houses which have been built for this purpose do not tend to raise the foreman's respect for himself or for his job.

The sanitary housing of track laborers depends much upon the foreman. Some foremen make it a practice to send a man into headquarters every Saturday afternoon to scrub out the bunk houses or cars and clean up the surrounding grounds. The foreman then inspects the houses or cars to assure himself that the man has made them scrupulously clean. The result of this system is that the bunk houses used by white men compare favorably with any other habitations in the community.

The laborers on the Boston & Albany R. R. usually can obtain board in private families, but it has been necessary to provide places for them to sleep. Old passen-

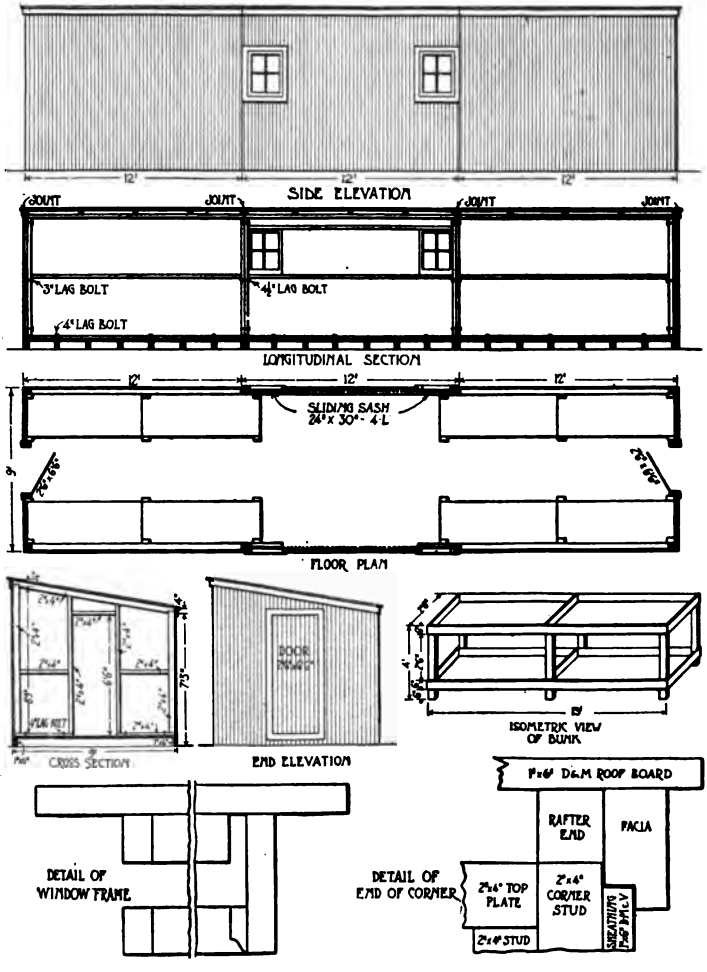

Fig. 1.—Standard Two-Room Bunk House, B. & O. R. R.

ger coaches have been equipped with bunks for this purpose—they provide an airy, light and sanitary housing as compared with box cars. Other roads have been able to make material improvements by paying greater attention to the box cars used for bunk cars—keeping them clean and sanitary and providing cleaner and better bunks and bedding.

On the Baltimore & Ohio R. R., where it is found necessary to do so, a two-room house of standard design is built which provides one room for the bunks and the other for the kitchen and living room. In places where the necessity for such quarters is only temporary, a box car is set off the tracks and adapted to living purposes by putting in the necessary doors and windows for light and ventilation. Although the house is divided off for bunks and kitchen, the men in most cases rearrange the interior to suit themselves. Regular section men provide their own bedding and kitchen utensils. The Chicago Great Western R. R. uses box car bodies set off of the trucks at the stations for housing laborers. Special pains are taken to make these comfortable with bunks, windows and doors. The Illinois Central provides camp cars and portable houses equipped with bunks.

(3) **Assuring Laborers Good Food**—Unless the supplies for laborers, especially for foreigners, are looked after by some of the railway officials, there is no assurance that the men will not be overcharged and furnished food which is unfit to eat. Since the laborer's ability to do a real day's work depends so directly upon the way he is fed, it is very essential that steps be taken which will not only insure the proper kind of food being furnished, but will prevent overcharges. In some cases the establishment of a company commissary or a commissary

department, or in extreme cases company boarding camps might be required. In sparsely settled territory the section foreman is sometimes allowed to board his laborers, and the men are usually satisfied with the food furnished. A good many railways allow section laborers to cultivate unused portions of the right of way for raising garden vegetables, etc. This not only helps to retain laborers, but helps the section work because it is unnecessary to weed or mow that particular portion of the right of way. These concessions increase the value of the section laborer's job.

It is very essential that track laborers be furnished good drinking water. At stations where this cannot be obtained, provision should be made to secure it elsewhere and to transport it to the station in clean tanks. The water should then be stored in cisterns in order to keep it cool and fresh. The practice of keeping the water in the tanks until the men use it is not only unsatisfactory, but insanitary.

Most railway companies arrange to guarantee the board bills of new laborers and deduct the amounts of the board bills from the laborer's pay. This arrangement helps materially in obtaining new laborers.

(4) **Foreman's Treatment of Men**—The day of the profane and wordy driver of men is over. It is impossible for a foreman of this type to keep a gang of men in these days of labor scarcity. A foreman must be energetic, not indolent, and must constantly devise methods to hasten the work and eliminate lost motion. Neither is there a place for the foreman who is over indulgent or too familiar with his men. Nowhere is the old saying, "Familiarity breeds contempt" more aptly illustrated than in the relations between foreman and laborer. When a

gang of laborers has a feeling of comradeship with the foreman, discipline ceases.

The position requires a man with unlimited patience, but one who exacts strict obedience while treating his men as human beings. Discipline is not loud talk; in fact some of the quietest men exact and obtain the strictest obedience. A gang which is well organized and well disciplined will remain on a job long after the poorly disciplined and poorly organized gang has left. It is human nature to dislike to work for an incompetent or a weakling. On the other hand it is surprising what can sometimes be accomplished with a gang working in a desultory manner when the men begin to see that their every move is resulting in the greatest progress for the energy expended. Gradually interest is awakened, and once the interest of even the poorest class of labor is aroused, the results can be doubled or tripled. The first feeling toward a foreman who "means business" all the time, is quite likely to be one of dislike; but if a little tact is sprinkled in with discipline, this feeling can soon be changed to respect and the foreman who has the respect of his men will retain them in his employ, other conditions being favorable. Organization and discipline go hand in hand. Proper organization guarantees the greatest results for the amount of energy expended, and discipline is necessary to obtain proper organization.

Discipline should be tempered with good judgment. As an instance, the general foreman on a new line, many miles from "civilization" discharged an interpreter. The result of this discipline was that the entire gang quit work until the interpreter was reinstated, and since a new gang could not be obtained immediately, and it was absolutely necessary to keep a gang on the job, the

general foreman was forced to reinstate him. Of course this act destroyed the foreman's discipline over the gang. Many times such a crisis can be passed over by using a little tact and not getting into a situation where it is necessary to make a display of authority. Then later, with the laborers in a different mood, the necessary order may be safely insisted upon. This does not mean that the wishes of the laborers should not be crossed, but it does mean that it is folly to arouse the antagonism of a gang for a trivial cause, or just to show authority; and this is especially true when the laborers are in a bad humor, as they are likely to be when surfacing in muddy ballast, when working in a rain or under other unfavorable conditions.

If a foreman makes a study of and adapts his methods to the particular characteristics of each man, he will gain the good will of the laborers and be able to retain them much longer than if otherwise treated. Some men must be driven, others will work on suggestion alone, others must be led, and still others must be influenced by instruction and example. Housing conditions, working conditions, rate of pay, etc., all have their effects on holding or driving away laborers, but the characteristics of the foreman, as evidenced in discipline, organization and intelligence, are of very vital importance in the solution of the problem.

(5) **The Possibility of Promotion**—Under no circumstances should outsiders be given the higher positions of assistant foreman, foreman, assistant roadmaster or roadmaster when there is material available in the company forces to fill these positions. In fact it is much better to take a chance on an old employe having the requisite ability, than to hire new untried employes, even

though they may be well recommended. If a company allows the section foreman to pay one or more men in the gang higher wages, it will usually be possible to hold these men long enough to develop them into assistant foremen.

The Baltimore & Ohio R. R. has a man in each gang called the "leading laborer," who is paid a higher rate than the rest of the gang, and these men are appointed assistant section foremen as opportunity offers. This method has helped materially in developing section foremen and in holding intelligent laborers, because they see a prospect of promotion. On other roads the section foremen are simply the best laborers picked out of the gangs. Such laborers receive the same pay as the rest of the gang and for this reason the more intelligent men are likely to leave before promotion comes. If the wages of the laborers were graded and a man could see a possibility of receiving increased pay as his ability increased, there would be a much greater likelihood of retaining intelligent men in the employ.

(6) **Instruction in Track Work**—The amount of instruction that can be given by the ordinary railway organization will of course vary, depending somewhat on the size of the road. It is possible, however, for the track foreman to obtain a good deal of valuable knowledge from the roadmaster and the track laborer from the track foreman, but in order to bring this about it is usually necessary to adopt a definite policy and issue orders to the officers concerned, suggesting in detail just what each is expected to do. On the Union Pacific it has been the practice for several years to educate intelligent and promising laborers by placing them in a school gang under a foreman of exceptional ability.

A little encouragement from higher officials will cause an ambitious trackman to read all of the practical books which he can obtain and all of the practical articles which appear in periodicals. A great deal depends simply on the expressed attitude of the higher officials toward education and the influence which it has on promotion. If in addition to this it were possible to delegate some one officer or committee of officers to draft up general instructions, and to keep on the lookout for good educational matter to circulate among the foremen, a great deal of good could be accomplished. Meetings of section foremen where there is an exchange of views and experiences are exceedingly valuable for educating the foremen, and similar meetings would be valuable for educating laborers. One railway is distributing newspapers and periodicals as far as possible to the employes, with the hope not only of educating them but of furnishing something for their entertainment outside of working hours.

(7) **Transportation**—Some railroads are exceedingly reluctant to issue transportation to trackmen, while employes of other departments are treated liberally. Of course this discrimination causes dissatisfaction among trackmen. Limited transportation should be granted after a short time spent in the railway's service, and a gradual increase of the amount of transportation allowed would result in an increase of satisfaction and efficiency among track forces which would more than offset the cash value of the fares allowed. On the Canadian Pacific the section foreman is allowed transportation as follows:

After 6 months' service, pass annually over the district.

After 1 year's service, pass annually over the division.
After 3 years' service, pass annually over the system.
After 5 years' service, pass over foreign lines.

(8) **Pensions**—Many railways have developed pension systems which help greatly to retain laborers. The Canadian Pacific system is a typical one; it allows for each year of service, 10 per cent of the average monthly pay received for the 10 years preceding retirement, or preceding the date upon which the company employe attained the age of 65 years, should he be retained in the service after such date.

(9) **Motor Cars**—Supplying the section forces with motor cars helps to keep laborers satisfied. Motor cars, if they are simple and reliable, pay big dividends. Not only do they save the energy of the laborers going to and from work, but they save from one-half to two-thirds the time which the hand cars would require to cover the same distance. The section laborer who rides on a motor car acquires a greater respect for his job. Some railways which do not feel financially able to purchase motor cars, will assume the expense of installation on a reinforced hand car and will also furnish a certain amount of gasoline per month for the foremen's use, provided the section foreman purchases a hand car engine.

(10) **Labor Saving Tools**—The gradual introduction of power devices and improved tools for the use of section laborers has tended to make the work less arduous. The use of such tools or appliances for disagreeable work is particularly profitable. For instance the use of a ditching machine for cleaning out the ditches in wet cuts or the use of tie tongs for handling creosoted ties, besides being a great deal cheaper, creates a decided impression of satisfaction on the part of the laborer,

for he sees that there is some consideration for him personally. Using poor tools or those inadequate for the purpose is exasperating and breeds dissatisfaction.

(11) **Graded Rates of Wages**—A conscientious employe certainly earns much more money after he has been in the employ a number of years. Instead of paying track laborers a flat rate therefore, the rates should be graded and a man's pay increased in proportion to the increase in the amount of work he does and the length of time he stays with the railway. The main objection to allowing graded rates of pay, possibly, has been the fear that foremen would show undue favoritism. Another serious objection to allowing graded rates of pay is that many roads specify that the older or permanent men are to receive the highest rate, which makes it hard to secure and retain the extra men that are employed only for a short period during busy seasons or in an emergency. Favoritism which would result in poor laborers receiving higher rates than their ability warrants is not likely because the roadmaster would be pretty well conversant with the capabilities as well as the rates paid the different men on each gang.

By offering section laborers an increase in pay with increase in knowledge and efficiency, as well as length of service, the railway would offer some inducement for the development of men for the position of section foreman.

CHAPTER II.

DEVELOPING TRACK FOREMEN.

The solution of the track labor problem will practically solve the problem of future track foremen. We use the term "track foreman" advisedly. A certain odium has come to be attached to the title of "section foreman." As a matter of fact, foremen should be able to do all kinds of track work (construction as well as maintenance), and so their title should properly be "track foreman."

E. R. Lewis, assistant general manager of the Duluth South Shore & Atlantic Ry., said in an article in the Railway Age Gazette:

"The responsibilities of the foreman are heavier and more continuous than those of the engineman or trainman. The foreman must be able not only to perform more physical labor than any man in his gang, and to do it more steadily, but he is required to send to headquarters some 20 different kinds of reports each month, to the total average number of thirty-five, besides telegrams concerning any ususual happenings on his territory. This clerical work begins each day when his track labor ends.

"He is timekeeper for himself and his men. He is responsible for safety of the tracks, switches, waterways, crossings and in many cases for switch and semaphore lamps on his section. He is responsible for track repairs and for emergency repairs to telegraph lines, bridges and culverts, signals and interlocking; for the safe conduct of his men and care over

main tracks without any safeguard in the way of train orders. He must know the time of arrival and departure of all regular trains and whether or not they are running late, timing his work accordingly. He must be as familiar with the flagging rules as are the trainmen and enginemen. He must effectively police the company's property against all acts of trespass and vandalism without any real police power. He is responsible for the proper care and appearance of the right of way and the fence enclosing it. He must deal as the company's representative with adjacent property owners. He has more than a hundred other duties to be found in detail in the rule books. It is not surprising then that employers of section men and foremen are often perplexed in the attempt to select foremen capable of filling all these diversified requirements."

The foreman must master the effects of varying conditions on the track, among which might be mentioned temperature, wind, moisture, friction, chemical action, stress, movements of trains and passage of time on the different materials. He must know the actions or preventives which will counteract the effects of these changes and he must also acquire what might be termed "railroad intuition."

A foreman must show more ability in his line of work than the men in the train or engine service because each foreman stands alone, while in other departments the employe has the support of his fellows. For this reason the foreman must be self-reliant and he must have keen judgment.

S. W. Kapp, in a paper before the Engineer's Club

of Philadelphia, said: "The track foreman must be posted on the operating rules, conditions and practices affecting the running of trains; he must acquire a general knowledge of the peculiarities of equipment and their effect on his work; he must be familiar with the requirements for shipment, receipt and inspection of material; he must learn to make repairs and renewals and do his work without unnecessary interference with the movement of trains—the most of this must be done without *any* interference; he must learn to discriminate between the many things calling for his attention so that he can take care of what is most important from an operating or maintenance standpoint, as the case may be; and he must maintain amicable relations with the railroad company's neighbors, his inferiors, superiors and his fellow employes.

While Mr. Kapp says a foreman must learn how to make repairs, etc., he doubtless means that he must learn this while he is still a laborer. Before a man is appointed foreman he must *know* how to do these things; he must *know* how to discriminate between the kinds of work and select that which is most important.

The track foreman must not expect 100 per cent efficiency from an inexperienced laborer and he must devote more attention to him than to an experienced man. Track foremen may be divided into three classes: (1) the hustler; (2) the brainy foreman who maintains a steady but medium gait, and (3) the man who combines both brains and hustling ability. Frequently the hustler does a lot of extra work because he does not plan out in advance the proper order in which to do it. The foreman who uses his head may work less and accomplish

more than the foreman who always hustles without planning his work. If a foreman uses his head and plans his work, and then pushes it hard, he will accomplish the most. Because a man is a hustler, then, is not an infallible sign that he is a first-class foreman.

A foreman should not be touchy and thin-skinned, for constructive criticism is necessary in developing a good trackman. He should always be ready and willing to do more than he is actually required to do, for then will he be worth more money to the company. He should be an enthusiast about his work, as this will not only increase his ability, but make his position more enjoyable and less of a drudge.

Necessary Versus Desirable Work.—There is plenty of room for the exercise of a nice judgment in track maintenance, and this is especially true in spring and summer when there is so much work that a foreman hardly knows what to turn his hand to first. Mr. Kapp, in the paper men ioned above, states that the relative importance of the different kinds of work is as follows: (1, that necessary for safety, (2) necessary for operation, (3) necessary by statute and ordinance, (4) necessary on account of road's requirements, (5) necessary for proper maintenance, (6) necessary for economical maintenance, (7) necessary for appearances, (8) necessary for improvement of any one of the above, (9) necessary to please the public, (10) necessary to please individuals of the public, (11) necessary to please officials of the road, (12) necessary to please individual railroad officials.

This enumeration shows that the section foreman must have no mean ability, and indicates the necessity

for proper training if even fair efficiency is to be maintained in track work.

One railroad official states that in increasing the efficiency of his foremen he has worked toward: (1) awakening the employe's interest, (2) awakening the employe's pride in his work, (3) cultivating a feeling of personal loyalty on the part of the employe, (4) increasing the skill and value of the individual, (5) making the employe realize that all this will work out to his own personal advantage and advancement. The awakening of interest is by far the most important because once a man's interest is awakened the other desired characteristics will follow.

Need for More Careful Maintenance.—The great increase in the weight of rolling stock and greater speed of trains has made better maintenance imperative. The track is called upon to carry an immense load, traveling over it at high speed, and yet no particular care is taken with the foundation. In fact the foundation usually consists of earth excavated in the immediate vicinity and compacted poorly, if at all. Some of the material which is used for embankments is very unstable and in order to make it carry its load, constant attention and a full understanding of track work are necessary. Thus, while it seems that the supply of good section foremen is decreasing, the necessity for good foremen is increasing. With good foremen, good maintenance can be obtained from even a poor class of laborers.

In spite of these facts many higher officials do not seem to realize that the status of the track foreman must be raised. They believe that when a good foreman leaves their employ a man of inferior mentality

will be found who can fill the position just as well.

Why Men Are Not Available.—The demand for laborers in farming and industrial lines has been generally cited as the cause for the scarcity of track laborers. This is true, but not the whole truth. The other railroad departments, particularly the train service, compete for the intelligent young men who start out as track laborers. It is not unusual for a newly hired brakeman to earn $100, or even more per month. Naturally an ambitious and intelligent track laborer, when he hears of the wages paid the brakemen, will compare them with his wages, or with the wages which a seasoned foreman receives; and most of the men will then make up their minds to get into the operating department at the earliest possible moment. The track laborer does not consider that the brakeman must pay his own expenses while on the road, nor does he consider the danger to which the brakeman is exposed.

One roadmaster states that he has found the scarcity of section foremen to be partly due to the decrease in construction work. Formerly men for the position of section foremen were obtained in considerable measure from the construction forces, and of course the decrease in construction has led to a decrease in the supply from this source. It usually takes four or five years for a track laborer to become thoroughly conversant with track work, but his education may be much hastened if he is transferred frequently and placed where experience can be acquired more rapidly.

The track foreman's wages are not high enough. The wages of a foreman of an outlying section where there is nothing but routine work are somewhere near

what they should be. But the wages of the foremen of main line sections and yards should be increased materially. The track foreman is responsible for altogether too much work for the wages which are paid, particularly when the foremen are skilled mechanics in addition to being foremen.

One reason the section foreman's position is unattractive is that he is on duty, subject to call, for 24 hours a day and for 7 days a week. Many roads do not pay a foreman for overtime, although some roads in the west now do. It is manifestly unfair to expect the foremen to work longer than 10 hours a day, without extra pay, even if his wages were what they should be.

Developing Men for Foremen.—We believe that in order to attract men to the track department it will be necessary to accord them better treatment than has been general in the past, and offer the following suggestions:

(1) Insist that the section foreman be treated with more respect—change his title to "track foreman" on account of the odium which now attaches to the title "section foreman."

(2) Provide comfortable habitations, where there are no houses which can be rented.

(3) Adopt a system of discipline which will not deprive the foreman of what he considers to be his rightful independence.

(4) Hold out definite possibilities of promotion as vacancies occur.

(5) Provide instruction in track work.

(6) Give foremen in charge of more important sec-

tions or larger yards higher wages than paid to foremen on sections requiring only routine work.

(7) Hold periodical get-together meetings of track men.

(8) Have the roadmaster take a personal interest not only in his foremen, but in his laborers.

(9) Grant transportation in amounts increasing with length of service.

(10) Furnish motor cars, if possible.

(11) Provide the foremen with good track tools and honor, to the letter, their requisitions for new tools or materials whenever possible.

(1) The Foreman's Title.—Every man who maintains track should be a track foreman and not merely a section foreman. A well rounded track foreman should be familiar not only with track maintenance, but with track construction. Railway managements should discourage or absolutely prohibit the employes of other departments ridiculing the track employes. This is one of the worst features which the track department has to combat.

(2) Track Foremen's Houses—Where houses are provided by the company, an attempt should be made to make them not only comfortable but sufficiently attractive to make the foremen satisfied with their appearance. The fact should not be lost sight of that the foreman's house must be a fit habitation for his family, both in appearance and comfort.

(3) Discipline.—In order to have good discipline the responsibility of each man in an organization must be clearly defined. In other words there must be no division of responsibility, so that a dispute might arise as to the authority of any one person. By carefully

defining a man's duties, his responsibility is increased and he is made to realize and live up to it better.

Of course, it is occasionally necessary to discipline foremen, but it is assuredly a mistake to dismiss an experienced foreman from the service for a trivial offense. Many roads have adopted a system (a modification of Brown's method), consisting of giving the employes reprimands, merit or demerit marks, or in extreme cases suspending them. The combination of reprimands and suspension, with dismissal only for a very serious offense which indicates that dependance cannot be placed upon a man thereafter, is probably the best. Where demerit marks are given, provision should be made for also giving merit marks so that a good record may blot out a bad one.

The discharge of a track foreman is usually more expensive to the company than it is to the discharged employe, because it disorganizes the work and takes from it a man who is familiar with the peculiar conditions in the territory. Further, a man must have a feeling of security in his position before he can develop his utmost efficiency and capacity, which is another reason for only discharging employes when absolutely necessary.

In order to be able to discipline his laborers correctly, the foreman must be given complete authority over them; higher officials should not interfere. The roadmaster should have complete authority over his foremen without interference from higher officials. This does not mean that those higher in authority should have nothing to do with these subordinates, but rather that they should, wherever possible, give all orders

through the roadmaster and foreman, rather than direct to laborers.

(4) Definite Possibility of Promotion.—While it is not possible to specify when a man can expect promotion to track foreman, or from track foreman to a higher position, it is usually possible to give a man an idea of the approximate rotation or order in which the promotions will be made; in other words, it is usually possible to make up a list of the names showing the number of men eligible for promotion when vacancies occur. An examination in track work and on the rule book should be required and where possible the examination should be competitive and promotions made from among the laborers who make the best percentages. A record should be kept of the date each man enters the service, in order to determine the man's seniority, and whenever a laborer fails to pass an examination he should be given a chance to prepare himself by study for the next examination.

(5) Instruction.—If practical instruction in track work is provided it will increase the possibility of the laborers' or foremen's promotion, and it will also increase the ability and better the service which the railway obtains from these men. The greater the opportunities provided the easier it will be to interest the kind of men who will make good foremen. Instruction can be given in methods of doing work by a committee of roadmasters or by the roadmaster himself; it it advisable to get out such instructions in written form so that the men can take their leisure time to read and digest them. The roadmaster, or other men delegated by him, should keep close watch of technical publications and pass along articles of education-

al value to the foremen. Foremen should also be notified concerning any books which will be a practical help. This display of interest in the foremen will result in increasing their interest and loyalty to the company as well as their ability.

(6) Grading Section and Yard Jobs.—It should be possible to grade the salaries paid foremen, from routine sections to large yards, so that a man may have a chance of increasing his wages as foreman by being transferred from section to section, and finally to the larger yards. This method would provide a possibility of promotion even before a vacancy occurred as roadmaster. The step from section foreman of an ordinary outlying section, to roadmaster, is a long one, and the foreman is likely to become discouraged before his chance of promotion comes. A promotion from section to section, even though the increase in salary is small, will help to keep the right kind of men interested.

New foremen should be appointed to sections where there is nothing but routine work, and promotion could be made to sections having intermediate yards, then to extra gangs, and then to terminal yards. The foreman of a terminal yard has the most difficult position in track work, with the exception of the roadmaster. He must have his men scattered all over the tracks, making repairs in a number of places at once, and his supervision is much harder than with an extra gang where the men are bunched.

(7) Periodical Meetings.—Periodical meetings promote a spirit of interest in the work and loyalty to the company. Also, valuable information can be obtained by the men airing their views and giving the results

of their experience. It is a big problem, however, to get the track men to talk at one of these meetings. A good method is to assign the foremen in rotation to take charge of the meetings. This will tend to put the rest of the men at their ease. Periodical meetings, where the men can be led to take part, will increase each man's confidence in himself, which will be a valuable asset when he is promoted to a higher position. While foremen as a rule are shy about making a talk in a public meeting, it is usually not because they do not wish to state their views, but because they are afraid someone will find fault with the manner in which they express them. When beginning these meetings it might be good idea to require each foreman to hand in his opinions in written form, and then gradually work up to the point where the men will feel free to speak at the meetings.

(8) Personal Contact with Foremen and Men.—The roadmaster can do much to keep his foremen satisfied by taking a personal interest, not only in their work, but in their personal affairs and social life. One roadmaster, in speaking of his treatment of foremen, says: "Nearly every man we have as laborer considers me his personal friend and I never visit a gang that I do not give the time of day to every one, calling those whom I know by name. I do not encourage familiarity or nonsense, and although I have charge of 55 miles of suburban lines and gangs scattered all around the city, and have to be on the road all the time to keep in close touch with the men, still I am able to get acquainted with this large force; and there is not a man on the road, either laborer or foreman, whom we refuse to help in time of sickness or trouble. Cloth-

ing, food or medicine will be supplied to tide over immediate needs. I take care of this personally and have lost very little money in doing so. The results of this treatment may be summed up as follows: I have nine foremen, the oldest being in the service 24 years, one 18 years and one 16 years—all but two being on the road when I came, one of these having followed me from the East. I have one laborer who has been with us 5 years, and many who have worked from 1 to 4 years. The backbone of our forces are men of from 1 to 5 years' experience, and I am full handed and have been right along."

Getting acquainted with the laborers will often benefit a roadmaster if he is willing to receive and act on suggestions regarding the work. Nearly every man has a hobby of some kind and being interested in a laborer's life study will make him a friend who will take more than a merely money-interest in his work.

(9) Transportation.—As mentioned in the previous chapter, free transportation should be provided for track men and foremen, the amount and territory covered being increased as service with the company lengthens; great liberality will be found a material aid in retaining laborers in the service. Some roadmasters grant passes with an air of granting a great favor—so grudgingly that the man feels indignant rather than grateful. This is an extremely poor policy and counteracts whatever favorable effect the giving of the pass might have.

There has sometimes seemed to be a good deal of favoritism shown in granting passes, nearly all of the other departments of a railroad being treated more liberally than the track department. This discrimina-

tion has a very bad effect and cannot be too highly condemned.

(10) Motor Cars.—Furnishing the section foreman with a motor car raises his position from that of an ordinary drudge to one who is looked up to in his community. It helps the foreman hold his men and makes it more nearly possible for him to keep up with his work. This, in turn, helps to make the foreman more contented with the conditions surrounding his work and leads him to put forth his best efforts in the company's interest.

(11) Tools.—More attention should be given to the requisitions of section foremen, both as to tools and materials. This will increase the authority and responsibility of the foreman, and ought to result in a lowered ultimate expense, because a foreman will naturally buy that which he can maintain with least expense. No one is able to judge as well as the foreman just what service is being given by the different tools and appliances. Appliances which reduce the amount of disagreeable or arduous work will increase the satisfaction among laborers and foremen and will result in ultimate economy.

Miscellaneous.—Many other suggestions have been made for interesting and educating men for track foremen. School gangs are considered of value, one man having suggested that the gangs should consist of twelve to twenty-five men, one-quarter of these to receive $2.00 a day, one-eighth $2.25 and one-eighth $2.50. The foreman should receive $125.00 per month and be eligible for the first vacancy as road-master. The gang should be sent from division to

division, wherever the particular work in progress would give the men a chance to learn the most. Men for the school gang should be taken from the regular section gangs, if at all possible. They have been used to hard work and they are entitled to whatever opportunities develop. Where it is impossible, however, to obtain men with the desired qualifications from among the regular employes, an attempt should be made to interest men of intelligence, first to become track men, and later to be put in the school gang. Accurate records should be kept to insure that apprentices are promoted in proper order.

A track man suggests that a foreman be given a bonus when he has developed an apprentice to a point where he can be promoted to section foreman. A suggestion has also been made that the length of sections be increased in order to give a foreman a larger gang and more responsibility, and thus enable him to earn higher wages. Motor cars would be a necessity if this suggestion was followed. Another excellent suggestion is that a study car be provided with the boarding car outfit of the school gang, in which periodicals and books could be kept for the men to read and study in their leisure hours.

On the Pennsylvania there is a class of men who are recommended by the foreman as being good material to be educated, and these men are transferred from section to section wherever unusual work is encountered. After passing an examination they get the title of emergency foremen and are eligible to the next promotion to section foreman.

The subject of hiring outsiders as section foremen has already been touched upon. Andrew Palm, a road-

master of wide experience, has the following to say about hiring outsiders: "Nothing discourages a trackman more than to have a man placed over him whom he considers, or knows, is not deserving of the position, and whose only recommendation is of a personal nature. He sees that his years of meritorious service amount to nothing. New men coming from other railroads are given the positions which are his by every right. Nothing but gross injustice is given him. Can we demand his respect? Certainly not. We cannot expect it when we give to others that which he has rightfully earned.

"Let us assume that every position, from laborer to chief engineer, belongs to our employes, and that no outsiders need apply except to take a position at the bottom of the ladder and climb up on merit, and that competitive examinations are the basis of promotions. Each laborer should have to pass a certain number of points before taking the first step in advance and prepare himself for the next step by practice and study. It should be impressed upon him that his success depends upon his endeavors in acquiring the knowledge to guarantee his promotion. By doing so, instead of reaping less than half a crop on stony ground after many years of toil we will reap an abundant crop from fertile soil."

The effect of allowing graded rates of wages, on the development of section foremen, has already been discussed. This method, or the method of having one "leading laborer" at a higher rate, has already been tried out and found to be a success. The principal difficulty with the apprentice system has been to obtain men of the required intelligence as apprentices.

Some roads watch the young fellows who are employed as timekeepers or water boys during school vacations. The roadmaster and foremen then select those whom it is thought will make good men and the roadmaster has a talk with each one of them, giving them an idea of the opportunities, and making each a proposition to start in as track apprentice as soon as his schooling is finished. This method has proven a success and is in quite extensive use.

PRESENT PRACTICE.

On the Boston & Albany.—No particular method of developing track laborers into foremen is followed on this road; but a general supervision is kept over all laborers, and when a man is noticed who it is thought would develop into a good man for such a position, he is looked after and given his chance and it is put up to him to make good. There is no instruction course, but there is an apprentice arrangement in every gang whereby the foreman has authority to pay one man more than the regular wages. The section foreman is obligated to give this position to a man who he believes can be developed into a foreman. There is no examination before promotion. The supervisor satisfies himself that the man presenting himself for the vacancy is capable of handling the work—under no consideration is he given the job unless he is considered capable of making good. These methods have been in vogue for about five years and have improved the working conditions of the track foremen over 100 per cent. It is a method which is adapted to a small road like the Boston & Albany and it has brought the section foremen, the better class of section men, the supervisors and the

higher officers pretty close together in their interests.

On the New York Central.—The apprentice system has been developed to some extent on the New York Central. The usual procedure is to pick out some young, bright fellow in the section gang and after he has been thoroughly trained, to give him the position of assistant foreman. After he has had the necessary experience, he is either made section foreman or assistant foreman of an extra gang. Such a man is not required to stay in either position any particular length of time, his promotion depending upon the vacancies which occur. Examinations on the book of rules are given before promotion. These methods have made the men loyal to the company by assuring them steady employment and promotion, and this loyalty has increased the reliability of the force as an organization.

On the Rock Island.—The Rock Island has developed a track apprentice system whereby a man is guaranteed work the year around. Apprentices are started at a salary of $45.00 per month, which is later increased to $50.00. When an apprentice has reached this point he is considered competent to take care of a section or extra gang, the pay in such positions ranging from $65.00 to $90.00 per month. Roadmasters are obtained from among these foremen. The foremen are checked up pretty closely and if they do not do satisfactory work they are released and other men appointed in their places. Apprentices are selected from the brightest men obtainable, young engineers and college men sometimes being employed in this capacity. They work under the instruction of a section foreman, take charge of the section ac-

counts, are brought into the roadmaster's office and instructed in regard to the office details connected with these accounts, and in any other required subjects. No promotional examinations are held, the men simply being advanced to the position of section foreman when the roadmaster feels they are competent.

There is no question of the value of the apprentice system but there is some difficulty in getting men of the right caliber interested. On account of the low salaries paid, it is only possible to keep men interested who appreciate the value of the experience and who are willing to work for promotion, not only to section foreman, but to roadmaster and higher positions. The full benefit of the apprentice system is therefore not obtained because the salaries at the beginning are low.

On the Baltimore & Ohio.—The position of leading laborer and of assistant foreman at a higher rate than paid the balance of the gang is held out as an inducement for the men to remain with the company and seek advancement. The company is ready to recognize industry and merit in the laborer and promote him to these higher positions and from these he can be promoted to foreman, supervisor and general supervisor.

There is no regular form of apprenticeship or instruction, other than the apprenticeship and practical instruction the men get in the positions of leading laborer and assistant foreman. It is the rule for supervisor and foreman to carefully select the men for these positions from the promising young men in the gang. In these positions the men are especially instructed by the foreman in the details of the work. They are

trained to handle men by being assigned to supervision of a portion of the gang over particular details. As a man shows capacity for increased responsibility he is promoted to the position of assistant foreman in an extra gang and drilled in the work of laying rail, ballasting, ditching, etc. It is from among these leading laborers that assistant section foremen and extra gang foremen are selected. Where it can be done the extra gang foremen are selected from among the regular section foremen. The men are gauged for promotion by the ability shown in the handling of the work assigned them and not by the examination test.

This method of selection, instruction, development and promotion of men through the test of practical achievement, assures that those with the requisite practical knowledge of the work and known ability as leaders will be chosen. These two qualities in the men holding supervisory positions, supplemented by a careful study of economical methods, raises the standard of the work and increases the efficiency of the working organization. It is thought that still further improvement in the method might be accomplished by a more elaborate system of preliminary instruction, somewhat similar to that of shop apprenticeship. However, the rather violent fluctuations in the appropriations for track forces makes steady employment uncertain. This robs it of any strong inducement that it can offer to the more enterprising and leads to the belief that any young man who has the ability and persistence to undertake and complete an elaborate apprenticeship course in this class of work would not long continue at it, but would find more attractive employment elsewhere.

CHAPTER III.

HANDLING LABORERS OF DIFFERENT NATIONALITIES.

A foreman should have patience and perseverance. He should be a student of human nature, have the ability to recognize the characteristics of different nationalities, and individuals among the same nationality, and to use these characteristics to the best advantage. If, in addition, the foreman has the characteristics of a good salesman—the ability to make friends and make people like and respect him—he has an added asset. The foreman should not become too intimate with a gang of men of any nationality; to do so will destroy discipline.

The Hobo Laborer—Outside of the American or northern European trackmen who used to be available for section work, the American hobo is conceded to be the best all around trackman. Even hobo labor, as a class, has deteriorated in recent years and it is seldom that one finds a real "old-timer" among the many men who are now sent out on railway construction work.

The hobo always demanded considerate treatment from the foreman; and a foreman could come nearer treating such men as equals than he could men of foreign nationalities. It is a much easier and pleasanter job to handle men who not only understand the English language but who understand track work thoroughly. And it is not an unusual case for the hobo laborers to know more about putting in switches, for

instance, than the foreman they are working for, since many of these men follow track and switch construction work exclusively and obtain a wide experience by working on many railways.

The outstanding characteristic of the old-time hobo is his pride—the feeling that no man in the gang can do more or better work than he can. This characteristic can be used to great advantage in organizing the gang, arranging the different groups so that the work of each man will be measured by that of several others in the same group. This not only increases the amount of work done, but it distributes the work of the laborers so that the whole job is more uniform.

The whole secret of handling a gang of hobo laborers is to get them organized right. In other words, if the men are placed at the kind of work to which they are best adapted and at which they have had the most experience, the work of the gang will move along smoothly and uniformly, provided the foreman has had enough experience to command the respect of the men and then handles them considerately.

The great drawback is the fact that hobo laborers cannot be depended upon, especially after having a pay day, and the further fact that the men always have some grievances concerning the board, the work, the boarding boss or some other official, and trump up various excuses for frequently quitting work and drawing their pay. For this reason it is almost impossible to keep a gang permanently employed and many changes are made in the forces each month. This means that there is frequent, costly reorganization of the gang, whereas with most foreigners, after the

men are once organized they can be depended to remain for a good deal longer time.

Good board is a very essential requirement for holding a gang of hobo laborers. Many contractors furnish the board for the men and provide good food in plenty, often losing money on the boarding camp, but making it up through the greater amount of labor which they obtain from the men.

When a foreman is organizing a gang, it will do him little good to ask for men who are good spikers, good bolters, etc. It is best for him to assign different men to the kind of work he wants them to do, and if they are not experts they can be changed later. The foreman who asks a man if he can spike is considered to have shown his weakness and probably will be unable to maintain discipline and get fair work out of the gang.

It is the usual thing for the hobos to complain of the board furnished at a railway camp, but it is a notable fact that they have very little to say about the board furnished by contractors who run their own boarding camps. One roadmaster made it a rule not to allow the hobos to make complaints except when they were at the tables; then he made it a rule to go through the cars at meal time once a week to listen to and investigate complaints. In this way it was easy to check up unsatisfactory conditions; this plan proved to be a benefit to both the hobo and to the camp.

The advantages of using hobo laborers are: they speak English, are familiar with the work, talk less while at work and cause less trouble than foreigners. The disadvantages of this class of labor are the refusal of the men to work at certain kinds of jobs and

their roving disposition which makes it impossible to depend on them to be on the work from day to day. Pay day is the hobo's Waterloo and it is the usual thing to lose a large part of the gang as soon as the men receive their pay checks.

While a foreman must understand hobos and must be experienced in track work to command their respect, the hobos do not expect the foreman to know everything about track work. If they take a liking to a foreman they will suggest quicker and better ways of doing things, ideas which they have gathered from wide experience.

The Italian Laborer—Frequently Italian laborers are looked upon by foremen as being tricky and treacherous—in fact as poor material out of which to make trackmen. Frequently these are not the characteristics of the gang but rather of the leader, the interpreter or whoever it may be, because the laborers see things through his eyes. There are among Italians, as in other nationalities, men who are tricky and looking for every chance to slight the work. On the other hand there are many Italians who make good trackmen; and if trained rightly some of them become almost as adept with track tools as the hobo laborer.

Probably the strongest characteristic of the race is thrift. Italians have a natural tendency to sacrifice everything to the accumulation of wealth, some even going so far as to partially starve themselves in order to save money, with the intention of returning to their native country to spend their declining years. But a good many Italians are becoming Americanized and have adapted standards of living equal to those of American-born laborers. These men make good citi-

zens, provide themselves with all of the comforts and many of the luxuries of life, and give their children a good education. The better men among the Italians are found to be faithful, loyal, steady and sober, honest in paying their debts and appreciative of any kindness shown them.

In starting a green gang of Italians at track work, the foreman must exercise the greatest patience, it being necessary to show one man over and over again just how to handle the different tools. The Italians are very well versed in the use of the shovel, as it is the tool which is used in Italy and one which many of them are used to earning their living with. They experience their greatest difficulty in learning to use the other track tools. After they get used to them, however, they become adept, as they are naturally quick. Some of the best spikers, in fact some of the best track gangs, to be found are Italians. With a green gang it is a pretty difficult job to put in a switch; and even with a gang which has been well trained and can use the tools correctly, some difficulty is experienced. Frequently this is due to unfamiliarity with the structure of the switch, however, and not to stupidity or unwillingness. The spikers in a green gang are likely to be found spiking the switch point down solid, trying to gauge the wrong rail, or doing other things equally as ridiculous.

The great objection to Italians is that the new emigrants, or those who expect to return to the old country, are inefficient both physically and mentally, as they do not feed themselves well enough to sustain their strength. Such a gang of green Italians is also inclined to be disloyal to the foreman and to shirk

work by pretending not to understand. It is difficult to get small gangs for sections because they are clannish and do not wish to separate.

The advantages of Italians for track laborers are that they can be depended upon to put in full time and if they make up their minds to stay in this country, they can be developed into good trackmen. In fact there are many Italian section foremen now, giving efficient and loyal service, and these have been developed largely without paying any particular attention to their education. It is certain that if a greater attempt was made to interest these men into training for a position as section foreman, that they would be better laborers and better able to become track foremen when vacancies occur. Italians as a rule do not use intoxicating liquors, but are fond of beer. They are seldom incapacitated for work on account of a Sunday or holiday spree, which objection can be urged against other types of foreigners.

Pole and Slav Laborers—The Poles and Slavs are robust and as a race are possibly more inclined to treat their stomachs properly than are the Italians, and are therefore usually able to perform heavy work. They are particularly efficient in large gangs and for handling heavy material such as rails, timbers, etc. They are not inclined to talk freely while at work and will produce a fair day's work if properly treated. Under a good Polish foreman they make good trackmen. They learn quickly and many of them have become section foremen.

They are law abiding, and good men for emergencies such as for fighting snow, working in the rain, etc. A good foreman can get a lot of work out of them,

particularly if he takes pains to explain just why work is done in certain ways; given a chance to learn, their interest is aroused. The extra gangs are usually quite contented, because they do not have that source of trouble, the gang leader; and they are not clannish. They do not submit easily to driving but may be led to do a good day's work. They work with double energy if promised a little time off at the end of a job. For this reason it is a good thing to line off or lay out the day's work and tell them that when done, they may knock off for the day. In this way it is possible to get much work out of them and to shorten up the day considerably.

They are capable of being very thoroughly organized and after a man has been assigned his particular work, he stays at it without much further attention from the foreman. They become adept at track and switch work if pains are taken to instruct them and to explain the reasons for every step in a job. They are not very quarrelsome and are possibly more easily handled than Italians. Where they are located remote from a city, rather than furnish their own board, they prefer to obtain it at the house of a Polish family; but they will board anywhere that they can obtain good, substantial food.

Austrian Laborers—Austrians resemble Poles to some extent but they are even more robust. Even the slightest built of these laborers is able to stand hard work. It is not an unusual sight to see a medium-sized gang of these men throw a rail clear across a flat car and onto the ground. They will do this just to show how strong they are and a foreman who compliments them and flatters them on their strength can

get a great deal of work out of them. They resent "driving" and are adapted to heavy work, handling timbers, etc., and to surfacing rather than to building track and switches. They have a failing for strong alcoholic liquors, sometimes appearing on the job incapacitated for work. They usually board themselves and provide nourishing and strength-giving foods without stint.

Macedonian Laborers—Macedonians make good track laborers because they have peaceful dispositions and are naturally inclined to respect the authority of the foreman. They are rather hard to teach, it being particularly hard for them to become adept in the use of the shovel for tamping or even for excavating. This is because they are not accustomed to using shovels in their native country. They are conscientious and loyal and are, in general, better men to have in isolated places than Italians or Bulgarians, or other nationalities which submit to the leadership of an interpreter. Macedonian men make good assistant foremen. They keep the men in good spirits and yet get a good day's work out of them. They make good trackmen and are as dependable as American foremen as far as their knowledge goes.

Bulgarian Laborers—Bulgarian laborers resemble the Italians somewhat in that they are usually entirely under the control of an interpreter. They are likely to band together to resist the foreman's authority; not openly, but in such a way that it is hard for the foreman to discover the man or men who are holding back the work. Even with such a gang, however, if the foreman keeps at it and presses them constantly with the idea of getting out a good day's work, they will

gradually improve. They are not as loyal and easy to handle as other types of foreigners; are not so thorough and usually seem to care little about the amount of work done.

In small section gangs they can be handled much easier than in large extra gangs, for the smaller gangs have no interpreter. They like to board themselves and are not inclined to stint the quality and quantity of food. The Bulgarians as a whole, are an undesirable class of men to train for trackmen.

Negro Laborers—A negro has no initiative and is very improvident. If he gets $2.00 ahead, he must stop and draw his pay and spend it. It is best to hire men with families for section work and to allow them a garden on the right of way; the women cultivate the garden. Some railroads have found it advantageous to enclose the ground assigned to them with woven wire fences, and to provide every possible convenience which will help to keep them permanently at one location.

The negro has the intellect of a child and must be treated accordingly. The foreman must be an absolute despot and allow no arguments, otherwise the gang will cease to respect him. Negroes frequently get into difficulties with officers of the law, and a popular foreman will bail them out and take installments to get his money back. The ability to borrow a dollar is a big inducement and helps the foreman materially in keeping his gang.

Usually it is necessary to maintain a company commissary train which issues food, shoes, clothes, tobacco, etc. This is a very popular feature with the negroes. They do not consider that the amount is

to be deducted from their pay but it seems to them as if everything which comes from the commissary car is free.

More work can be obtained from negro section men than from extra gang laborers, but even the section laborer will divide his time between the railway, farming and loafing, so that the total amount of work gotten out of him on the railway is not very great.

The extra gang men shift from gang to gang, but stick at railroading. The men flock to the foreman who is popular—his reputation travels over the whole district. The negro must have his day off frequently to spend his money. A pass makes him an important man among his neighbors, so that occasional free transportation is a great inducement for the negro to stay on the job.

The best results are obtained under the stimulus of the active leadership of his white superior, as the negro does not want to be considered deficient physically. If he is kept well fed and housed he is contented. Rations in plenty are a very great incentive for him to remain on the job; he never thinks of providing for the future.

The negroes do best in small gangs. The men work in unison, the leader singing and the others grunting an accompaniment. When a gang is quiet there is something wrong; they should be kept laughing and singing in order to obtain the best results.

The negro likes big jobs and is not thorough and painstaking in small ones. He has the strength and courage for heavy work. After a gang is organized the men will continue working as placed and are easily supervised, provided the foreman has their respect.

It takes a good foreman and a good cook to hold a gang of negroes. The foreman must enforce strict discipline, be fair and just, and keep the laborers impressed with the fact that they are negroes. Familiarity with the men will soon destroy the foreman's control over them. The negro is very susceptible to flattery, is faithful and loyal and becomes attached to the foreman whom he respects, and his word becomes law. While he has little initiative he is a good imitator.

The loud-talking foreman who shouts his orders but is firm in insisting on obedience is usually the most popular with these men. The straw-boss, or unison man, has a different rhyme for each kind of work, and the men understand from the tune which he sings the kind of work that they are going to do, and this helps eliminate personal injuries. The foreman must understand every bit of the work and be expert in handling this kind of labor, and must always treat the men as a master does his servants, otherwise he cannot hold their respect. The negro is childlike in obedience to the foreman he fears, and loves and respects him. Furthermore, he will work in summer or winter weather, rain or shine, though sometimes the foreman has to go into the camp and drive him out with a club.

The Mexican Laborer—The Mexicans make good track laborers and give satisfactory results, as is proven by the great demand for them. They are intelligent and versatile, but untutored. The system under which they have been raised dwarfs their sense of responsibility, and although they are obedient they must be told every move to make. They carry out the most exacting details satisfactorily under supervision, but

not if left alone. They are peaceable under normal conditions; even the pay day spree is usually peaceful. Mexicans are merely grown up children, and after they have been in track work in the United States, where they see good examples, some of the best amongst them will gradually quit their pay day sprees and become steady citizens.

The employer must provide for their physical wants, as they are unable to do so themselves. They have no business honor—they have not been trained to know what it means—and think it no discredit to avoid paying their bills. For this reason the foreman must always give security for them before they can buy anything on credit. This has necessitated a sort of protective commissary which it is not possible to keep entirely free from graft. The Mexican has no sense of provision for the future and uses up everything he makes as he goes along.

They are loyal to their superiors, in general, and if given food and coffee and not taken advantage of, they will work almost any number of consecutive hours for a foreman whom they respect, without driving. The foreman must expect to find them untutored and unlearned, and vast patience must be exercised in giving them detailed explanations of how work should be done. The foreman should know the Mexican language to handle the men right; they will not tolerate abusive language, but if treated well will be the foreman's loyal subjects.

It takes them two weeks or more to get fed up after coming from Mexico, after which they are more capable of doing a man's work. The married men are loyal to their families. They are susceptible to flat-

tery. Frequently when they strike they will leave if the demands they have made are granted, while if they are not granted they are just as likely to return to work. Many times they strike and can't give reasons for doing so. A good company commissary is a very important thing in holding this class of laborers.

The Hindoo Laborer—The Hindoo laborers are not strong or robust but they learn easily and quickly. They soon come to understand the English language and are quite reliable even when not under direct supervision. They do as they are told, never find fault and are generally very easy to get along with. As a class they are too tall to use the pick and shovel most effectively. They generally prefer contract work to track work.

They keep their habitations in good sanitary condition, never appear on the work intoxicated nor do they smoke on the work. They have very peaceable natures and do but little talking when working. Their gangs do not contain agitators. They are fatalists and will go into dangerous places where other men refuse to go, and will work long hours when requested to by a foreman they like. They have many fast-days which leave them weak. They are dishonest with one another and consider that stealing is no crime. They seem to have a distaste for track work, but a foreman who gives them instructions carefully can do very well with them.

The Japanese Laborer—The Japanese are ambitious and intelligent, and are easily instructed because their minds are receptive. It is not necessary to repeat instructions as often to this class of labor as with most other foreigners. They are sensitive by nature and

are cleanly and sanitary in their habits and habitations. While they are small in stature, they are robust and have great vitality. They make good ballasting gangs, each man being capable of about the same amount of work as the others. They are very thorough with whatever they undertake. They soon master the English language, a great many of them making it a rule to learn three new English words each day.

They are temperate, seldom drinking to excess. They provide themselves with nourishing food, about one-half of their food being rice, the other half being other cereals and vegetables. The only trouble with them comes through gamblers who are brought in by the interpreters. These men frequently cheat the laborers out of all the money they have left after pay day; this is usually made possible by the co-operation of the interpreter who tells the men that they must gamble or lose their jobs. When these leaches are in the gang it is almost impossible to get good work out of the men or to keep them contented.

They dislike to work for a foreman of any other nationality than English or Canadian. If they are treated considerately they can be educated quickly, though occasionally a stubborn gang is encountered. A gang of this kind should be discharged because it is almost impossible to ever do anything with them.

Most of the Japanese, however, are loyal to a foreman who is considerate of their welfare. The Japanese make good foremen themselves, but have to be educated in tact and discipline. Probably four-fifths of the laborers will make good foremen if they are given a good course of training under a practical man.

The Union Pacific has a Japanese school gang, consisting of men who signify their intention of becoming foremen, and these men take up track work very rapidly and make excellent foremen. They are good scholars and master details quickly, have a sense of duty and very seldom repeat an error. After a Jap becomes a foreman he is capable of handling almost any nationality

Conclusions—The writer has found many who disagree as to the characteristics of different classes of laborers as described in the foregoing. If anyone has taken up the subject he will realize the great difficulty in gathering opinions on such a subject and making them agree. Disagreements will be noted in the opinions of two men on the same railway on adjacent territories, regarding the characteristics of a particular nationality, it being not infrequent to find statements from such men which are directly contrary and conflicting.

This is explainable only by the fact that there is a difference among people of the same nationality and among gangs of the same nationality. Doubtless there are many good gangs of every one of the nationalities considered and poor ones also, so that it is hardly possible that everyone will agree with the opinions expressed herein. An attempt was made, however, to obtain opinions from every possible source on this subject and it is the opinions of the majority which are given.

There is one feature which should not be underestimated in handling a gang of any nationality, and that is that the men should, if possible, be kept in a cheerful state of mind. With almost every gang this

will result in increasing the amount and decreasing the irksomeness of the work. Of course there are times when it is necessary to adopt opposite tactics which will put the gang in a bad humor. Sometimes men will work harder if they are mad. If they are treated in this way continually, however, they will gradually become dissatisfied and take advantage of every possible chance to shirk the work.

CHAPTER IV.

RENEWING TIES.

A track is no stronger than its weakest point. It is better to have uniformly fair track than to have stretches of excellent track mixed with stretches of poor track.

The cost of ties for renewals only, in the United States, is at present about $55,000,000 per year, not including the labor cost to distribute and put them in and to dispose of the old ones. This amounts to about 15 per cent of the entire maintenance of way expense and indicates the necessity for economical methods. It is important, then, to adopt the best methods of spotting the ties which are to be renewed, the most economical methods for doing the work, and if possible to arrange to do the renewal work at the time of the year when labor can be most easily obtained.

Barking Ties—Experiments at the Forest Products Laboratory at Madison, Wis., have shown that bark is very impervious to water. The resistance varies in different woods; it has been demonstrated that a piece of bark not much thicker than a piece of paper will prevent any penetration of preservative under very high pressure. This would seem to be a strong argument in favor of leaving the bark on ties when they are put in track.

However, as most trackmen know, the bark causes trouble if left on the ties, because it soon becomes disengaged from the rest of the wood; and when the track is being raised the bark loosens up and becomes entangled in the laborers' shovels. Part of the bark

is likely to be tamped under the tie and will afford poor support to begin with, rotting early and making the support still poorer, and also making it necessary to clean the ballast much sooner. When, in addition, consideration is given to the fact that the interior of the tie will become seasoned much better if the bark is removed, it seems sound policy to continue to bark ties as has been the standard practice in the past.

Adzing and Boring Ties—Investigation has shown that the ordinary cut spike driven in an unbored tie tears and destroys the wood fiber, not only decreasing the holding power of the spike, but promoting early decay. This damage can be largely prevented by previously boring the tie and using diamond pointed spikes; if the holes are properly bored, the spikes can be driven straight even by poor workmen and knots will not deflect the spikes when they are being driven. It is quite common practice to adz and bore ties previous to subjecting them to a process for preservation. This practice may be economical with ties which are not to be treated provided they can be assembled at some point without too great an expense.

The great objection to boring ties is that the exact size of the rails to be used must be known when the ties are bored. But sizes for main line rail will not vary much on first-class track; therefore it should be possible to arrange for adzing and boring ties for such tracks without great difficulty.

Experiments made at the University of Purdue several years ago showed that a 9/16 in. square spike with diamond point, driven in a ⅜ in. hole, showed an average holding power of 8178 lbs. The same spike driven without boring had a holding power of only 7613 lbs.

These figures are the average of 18 tests on creosote, zinc chloride and untreated ties.

Adzing by machinery has the advantage of being cheaper than adzing by hand labor; but more than that, it is accurate and gives a uniformly level seating for the rails. On roads where there is no provision for adzing ties before being sent out on the track, it is good policy for the section forces to adz the rail seats in the winter time, using the Ware tie plate gauge and surfacer. It is cheaper to adz ties before they are placed under the rails. With the Ware surfacer, adzing may be carried on in the winter time and so provide a means of holding trackmen.

Sawed Ties—A great many men, unfamiliar with track work, advocate the use of sawed ties exclusively. They claim that a sawed tie can be made with less waste and out of poorer timber than a hewn tie. The trackman believes this thoroughly and can prove it by citeing the shorter life of his sawed switch ties in comparison with the life of the ordinary hewn track ties; and it is because of the shorter life that the trackman objects to the sawed track tie. While hewn ties must be adzed at an additional cost, the superiority in the quality of the timber from which they are made more than justifies their use.

Sawed ties of poor timber, unless treated, will not last long enough to justify the expense of inserting them. One trackman claims that a saw will open the pores of the wood while an axe tends to close the pores, which is a further reason for the superior service obtained from hewn ties.

Renewing Ties to Face—There has been much discussion on the relative advantage of renewing ties

singly or to face. If the ties renewed to face are firmly tamped, and are put in with the minimum disturbance of the old tie bed, they are nearly as solid as the old ties. In fact, they may be fully as solid as old ties, because the wood is hard and the tie does not compress as the old ones do when heavy trains pass over the track.

If the wheel loads are not carried uniformly by each tie, the load transferred to or supported by the ballast underneath the ties, will not be uniform, and this tends to break up the old tie beds as well as to cause excessive concentration of the loads on some ties. And if the load is transmitted unevenly to the ballast in the first place, a greater depth of ballast than otherwise needed will be necessary to secure an even distribution on the sub-grade.

Most trackmen are opposed to renewing ties to face because it loosens up the whole roadbed at one time and allows excessive creeping of the rails. Another objection brought up is that after the ties have been in the track the maximum length of time they are all weakened at the same time.

If ties were renewed to face the work could be done at a less cost per tie, but this may be compensated by the fact that ties might be removed which have a year or a year and a half more service in them, yet after being taken out of the track will be broken up so that they are not fit to be used again, even in side tracks.

While general opinion seems to be opposed to renewing ties out of a face, a few roads are using this method and it has some very staunch advocates.

Mr. R. P. Trabue, General Roadmaster of the Nashville Chattanooga & St. Louis Ry., says that he has

found the following advantages in this method: (1) It is seldom necessary to disturb the ties between renewals, and this minimizes mechanical wear on the tie and the powdering of the ballast caused by tamping; (2) it gives each tie an equal bearing; (3) the spread of the fungi which causes decay is lessened when sound ties are used throughout a stretch of track.

He states further that actual experiments have shown a life from six to seven years for the ties with a great reduction in maintenance. Renewals are always made soon enough to maintain the track in safe condition. He makes a strong point of the decrease in the mechanical wear on the ties and the saving in ballast because the track does not have to be disturbed as often if renewals are made out of a face.

The Correct Distribution of Ties—The correct distribution of ties, like the distribution of all other track material, is important. Since the winter months are generally used for distributing ties, time is usually available for making a careful distribution. And a careful distribution will save the cost of redistribution and make it possible to increase the amount of work done when renewing. Ties should not be piled on bottoms where spring freshets will float them away; neither should they be rolled down embankments because it is laborious and expensive work to carry them back on the grade. If possible the piles should be located so that the ties can be trucked down grade by the section gang. When unloading ties from cars, a gang of men should follow the train to pile up the ties at highway crossings and also to pull all ties in the clear. One method which has been used to aid in distributing ties correctly for renewals is to count up the

ones marked for renewal and write the number needed on the telegraph poles. White crayon is excellent for marking the telegraph poles, and the figures should be made large enough so that they may be seen plainly by the men on the tie cars.

On high fills particularly, it is good policy to shove one end of the ties off onto the ground and then let them drop as the train pulls ahead. This will distribute the ties parallel to the track and prevent them from running down the embankments. This method is also a good one to use in cuts, as the ties are not so likely to roll in under the cars. Another method is to shove one end of the tie off onto the grade first, and then drop the opposite end off parallel to the track without starting the train.

Inspecting Ties for Renewals—Different methods are followed in inspecting ties, but most roads have some method of following and checking up the foremen's estimates. The foreman will naturally order and use all the ties he can get so that he may keep his track in the best condition; in fact, he is likely to defeat economy in the fear that "next year" his supply of ties will be cut down. Then also he finds it much cheaper to take out the ties in bunches of three or four, or at least two in a place, in order to decrease the amount of digging, and thus increase his day's work without an increase in the amount of labor done. For these reasons, while the original inspections and reports on the ties to be removed should be made by the foremen, the reports should be checked up by the roadmaster, supervisor, tie inspector, or even the engineer of maintenance of way or the superintendent. Ordinary practice is to have the foreman make up his

report and to have the roadmaster go over the track with the foreman to determine in a general way whether his recommendations are economical.

Tie inspectors who have to go over the entire system are unlikely to be acquainted with local conditions and their recommendations are sometimes found to be unsatisfactory. Many railroads, however, report having found the work of tie inspectors to be satisfactory and economical.

Tie inspectors who are not trackmen do not accomplish good results. Frequently such a man will declare that an estimate is out of all proportion to the needs of the section, but this is often simply a method of trying to browbeat the foreman into acknowledging that he can get along with a smaller number of ties than he has estimated. This frequently results in the foreman being forced to repair unsafe places in mid-winter, using ties that were being seasoned for the next year. It would be preposterous to have a track foreman "expert" the auditor's books, and it is equally fallacious for an office man to attempt to give foremen pointers on how to economize in tie renewals.

The inspection of ties should be made the previous autumn, so that there will be plenty of time to order, ship and distribute the ties for the next season's work before the frost gets out of the ground in the spring.

Inspection in Detail—Inspection of track ties should be very thorough in order to show without fail all those which should be removed; but good ties should neither be spotted for renewal nor badly mutilated by testing with a pick or adz. It takes a trained eye to tell just which ties should be removed. Frequently a tie which shows very poorly on the top will have a

solid center and careless work in inspecting or marking it with a pick or an adz will make it unfit for service. The tie on each side of a rotten one should be inspected carefully, for it is cheaper to remove several ties at one time in one place, than to remove them singly.

There is no economy in removing one tie from track at a place where there are two bad ones together. This will apparently save one tie, but it really adds to the cost of renewals because the same place will have to be dug up the following year to renew the remaining bad tie.

Traffic conditions should be carefully considered when marking the ties which are to be renewed, it being necessary to maintain with a high factor of safety, track which is to be used under high speed traffic; and it is necessary to have sounder ties on curves than on tangents.

One railroad requires an inspection or test with a pick on each side of the tie, under the rail seat, to show the interior soundness. Any marks with an adz or a pick on the top of the tie provide a place for moisture to collect, and thus promote the work of decay. To determine whether a tie is breaking under the rail seat one has only to drive the pick under the end of the tie and pry up lightly. Sometimes it is necessary to remove a tie which would give a year more service, because it is adjacent to another tie which, while not bad enough to justify renewal, still is not sound enough to insure absolute safety at such a place. If an insufficient number of ties are provided and there are places where several poor ties are located adjacent to each other,

every other tie should be renewed in order to keep the track safe.

A tie which has been rail-cut more than ¾ of an inch should be replaced. Ties should be taken out of track when adzed down over ¾ of an inch; if the interiors of such ties are sound, they can be used in sidings or in stub tracks. Special attention should be given to ties in road crossings or other places where they are not easy to get at, and to soft places in the roadbed where the track must be shimmed in the winter time, as it is very essential to have sound ties in such places.

When relaying track it is frequently the practice to put in all new joint ties. In such cases some of the old ties may be sound enough to be used in side tracks.

Many trackmen do not mar the ties at all in testing them, but decide on their condition from an examination and merely by stamping or pounding on them. It is well to bear in mind that many ties which show up bad at the ends will be found good for another year or two on making an investigation, by removing a shovel full of ballast and exposing the tie under the rail.

Marking—Different standards are followed in marking ties which are to be removed, some roads requiring a mark with an adz on some part of the tie, while other roads specify that the rail be marked with a paint mark. One road requires that one corner of the tie be cut off with the adz. A definite system should be used and an easily distinguished mark made—a mark which the distributing gang from another division of the same road would easily recognize.

Inspection After Ties Are Removed—Many rail-

roads now make it a practice to inspect the old ties taken out in order to determine whether or not the system of inspection is working out right and preventing the removal of sound ties. The roadmaster, engineer maintenance of way or superintendent usually makes this inspection, calling the attention of foremen to good ties which have been removed. This follow-up inspection has materially increased the service obtained from the ties as a whole.

The Pennsylvania Railroad has special men who inspect the ties taken out of and also those left in the track. The inspectors report to the engineer maintenance of way, after which proper steps are taken to educate the men in better methods. If, in making these inspections, serviceable ties are found, they are loaded and used in the ends of stub tracks which are used mainly for storing cars—places where no locomotive is likely to run on them.

Where to Start the Renewals—If there are places where a large number of rotten ties must be renewed close together, the foreman should start at that point. This condition may occur on the first renewals in a track where all the ties have been in service the same length of time. It may be necessary to run over a track with a large percentage of poor ties, putting in just enough new ties to hold the track to gauge, until such time as the entire number can be renewed. The foreman should always give the weak places in the track his first attention. On curves with very poor ties, the foreman should insert a new tie in every half rail or at every quarter point and when the curves are strengthened in this manner he can run back and finish the renewing.

Tight Track—When ties are being put in a track which has insufficient expansion, the foreman must work carefully to prevent the rails kicking out or kinking by reason of taking out too many spikes or ties at one time. The danger is greatest on a hot day, and since the track is most likely to kink under a train, the foreman must, for safety's sake, keep the new ties spiked up as fast as put in.

Uniform Sized Ties—Since the frost will penetrate quicker under a narrow-faced than under a wide-faced tie, and conversely since the frost will go out quicker from under the narrow-faced tie, the different sizes should not be mixed up in the track any more than necessary, either in original construction or when renewing. This is a hard condition to meet practically, but should be borne in mind when distributing ties for renewal. If the frost gets under some ties quicker than others, it is likely to cause heaving.

Methods of Renewing Ties—No matter what method is used for renewing ties, they should be adzed before being put under the rail, and the outside spike line marked by the foreman or a competent laborer using a tie fiddle. The tie fiddle plays an important part in expert tie renewals. Much time is lost in argument and measuring when any other method of lining ties is used. Tie tongs should always be used, whether loading, unloading, carrying or putting ties into the track. Not only do these tools make the work easier for the men, but tie tongs prevent holes being made in the tops of the ties—and such holes are reservoirs for the retention of water which promotes decay. Tie tongs have been found to greatly facilitate the work, even when handling old rotten ties, and are especially val-

uable when handling heavy switch ties or heavy timbers. The laborers dislike to handle oil-treated or chemically-treated ties with their hands, and with tie tongs they do not have to touch them, so that their use results in helping to hold laborers.

Ties should be uniformly spaced, since unequal spacing causes heavier loads on some ties than on others, and this is one of the causes of mud oozing up between ties. All necessary re-spacing should be taken care of when renewing ties.

Renewing Ties in Gravel—A great many roadmasters are now using jacks when renewing ties, raising the rail 1½ to 2 in. and removing the tie by digging out at the ends and but little in the center of the track. A new tie is then placed on the bed of the old, an effort being made to choose ties which will fit in the old tie holes without being too wide or too high. Contrary to general opinion, the gravel will not run in under the tie when raised as high as necessary for this method except when the track and gravel are new, at which time tie renewals are not necessary. It is necessary to put in the new tie before a train runs over the track; the side friction will hold the ties up only until the first train passes.

S. J. Evans, general foreman of the Central California Traction Co., describes a method which he has used in gravel where the track is in good surface. The men shovel-tamp the new ties to the rail and then jack the track up high enough to slip the tie plates under, after which the new ties are spiked. The surface of the track is left a little "lumpy," but in a few days the ties will settle and the track will come back to its orig-

inal surface. He has found this method to be not only superior, but much cheaper than bar tamping.

The objection to using the old tie bed when inserting the new tie is that usually the rail will have cut down into the old tie, even if tie plates are used, to the extent of ¼ to ¾ of an inch. Unless thinner ties are available, therefore, the track will be left too high if the old tie bed is used, so that an excessive weight is carried by the new tie until such time as the old bed is broken down and the track settles to its original surface.

Renewing Ties in Dirt Track—In renewing ties in dirt track, a pinch bar is handier for raising the rails than a track jack. The tie adjacent to the one to be renewed is deadened, and the track may then be pinched up and a spike placed on the dead tie under the rail base, which will hold up the rail while the men are taking out the old tie, digging down the bed a little if necessary, and putting in the new tie. The tie should be put in "stiff" so that it will have to settle one-half inch or so to come down to the level of the other ties.. Before renewing a tie, the dirt which is rounded above the tie in the center must be removed; otherwise it will be scraped off and left in the old tie hole as the tie is pulled out.

Renewing Ties in Stone Ballast—J. P. McAndrews of the Chicago & North Western Railway, advocated the following methods of renewing ties in stone ballast, in an article published in the Railway Age Gazette. "The best way to renew ties in stone ballast is to raise the track 1½ to 2 in. and renew ties at the same time. With sixteen men, part of these can be assigned to tamping the good ties as soon as the jack-

men raise the track, and the rest of the men can remove the rotten ties and replace them with new ones. With this method it is not necessary to disturb the old tie beds and practically all ties get the same seating; there is not much danger of the new ties settling and having to be gone over again.

"If the ties are to be renewed without raising the track, one man should be given the clawbar and sent ahead to pull all the spikes on the marked ties, unless several marked ties come together, in which case enough ties should be left spiked to hold the rails safely to gauge. Men with shovels and picks should then remove the ballast just inside the rails so that a man can take an axe and chop the tie in two at these points. The tie may then be removed in three pieces without any side excavation. The new tie is put in with the least possible digging, the ties being chosen so that they fit in the old holes as nearly as possible. The new ties should then be tamped but not completely filled in, so that they may be again retamped in a few days without having to dig out the stone ballast again."

Mr. McAndrews' method of giving the track a general raise of 1½ to 2 in. is an economical method in gravel as well as in stone ballast, and leaves good track with each tie having an even bearing. Where the embankments shrink and leave center bound track it is of course the very best method to use. S. J. Evans states that with this method in good loose gravel the tie men (following the surfacing gang), can put in from 24 to 28 ties per man, the tie men removing, replacing, spiking and tamping the new ties. The tie

men work in pairs, each pair having a pick, two shovels, a spike maul, gauge and clawbar.

When renewing ties the track should be spiked to gauge and the new ties spiked in correct line. If necessary, the old ties should be spaced adjacent to the new ones and everything done to make a good piece of track before leaving it.

Costs of Renewing Ties—The cost of renewing ties has jumped to figures undreamed of in former years. The cost of renewing a tie in stone ballast is so high today, that every effort must be made to lengthen life of ties. In the past some officials have tried to cut the cost of renewing ties down to "make a record." They chase their foremen hard, calling attention to the record of any man who is able to do more than the rest, with the result that soon the section foremen lose all interest in carefully renewing the rotten ties and strive only to make a big showing of putting in new ties. This often results in ultimate loss to the company because a number of good ties adjacent to a rotten one will be removed in order to cheapen the work.

Another evil of this attempt to make records is that the foremen may pad their reports, either reporting a larger number of ties than they have actually put in, or charging up some of the time to general repairs or to some other item of track work which it is difficult to check. The honesty of the track man and ultimate economy in handling ties will be promoted in setting up and expecting, as an average, no more than a *fair* standard day's work. The padding of reports can be stopped by having an inspector or a general foreman go over the sections every day, taking note of what

each gang is doing and then checking up the foremen's report.

Disposal of Ties—Many railroad companies instruct their section foremen to pile and burn old ties. Some railroads carry this to such an extreme that it is difficult for the section men even to obtain old ties for firewood.

Aside from the expense incurred in gathering, piling and burning ties, the effect of destroying them is likely to have a bad effect on the men, as they realize that the wood might be used for some useful purpose. Some railroads make it a practice to give the ties to farmers along the right of way. This is certainly much better than burning them. It entails less labor on the part of the company employes and gains the good will of the farmers. Some railroads have been able to develop a sale for these old ties to be used as fence posts. Arrangements can sometimes be made with the farmers to do right of way mowing in exchange for the old ties. The great danger of giving away or selling ties is that the foremen in their attempts to do someone a favor or to turn in a large amount of money to the company treasury, will discard ties which might be used to advantage for two or three years longer in the track. One roadmaster, however, reports that he has sold a good many of his ties and that the sale nets the company a neat sum annually. Where the inspection can be made by the roadmaster and there is no danger of getting rid of good material, the sale of course would mean a material addition to revenues. It is perhaps needless to say that if there is no demand for the ties they should be burned rather than to be left to litter up the right of way.

CHAPTER V

RELAYING RAIL

Relaying in Winter—Objections have been made to relaying rail in the winter, because of the fact that joint ties cannot be spaced at that time. The Pittsburgh & Lake Erie and the Lehigh Valley, however, started to lay main track without spacing or slotting the joint ties several years ago. This method was adopted after careful consideration, and at the same time angle bars were adopted which were designed to make the joint as stiff as the rest of the rail. These installations were looked upon as experiments, but the Chicago, Milwaukee & St. Paul, the Chicago, Rock Island & Pacific, and the Illinois Central have since tried out this method.

With track laid in this manner, where a sufficient number of rail anchors is used, all ties will constantly remain on their hardened beds. Even when the track is raised or surfaced the tie, being raised vertically, will still have a hard bed beneath it. With joints slot spiked and track insufficiently anchored, when rail creeping commences the joint ties are pushed off of their beds. Joint ties should not be required to resist rail creeping, because they are subjected to more severe vertical pounding than the other ties.

It is stated that as good a job can be done relaying track in the winter as in the summer, if the foreman is careful to shim over the low ties, plug the old spike holes and in other ways attempt to make an especially good job. In the spring the shims are removed by the regular section gang when removing the shims from heaved track.

One great advantage to the railway of laying track in winter is that experienced track men may be retained for this work, instead of being laid off in the fall. It is a great advantage to the laborer and to society in general to have an additional number of trackmen employed the year around instead of being out of work in the winter.

No matter when the work is done the old spike holes should be plugged up. Good spike hole plugs ready for the holes should be provided in plenty, and should be kept in and distributed from bags to prevent loss.

Distributing Track Material Accurately—Accuracy in distributing spikes, angle bars, bolts, nut locks, and rails is highly repaid. Unloading track material cheaply and with the least expenditure of labor and energy is desirable, but it is equally desirable that the correct quantities be unloaded, and that they be placed at the correct points along the right of way. The money saved by a cheap method of unloading track material may be overbalanced by the increased cost of track laying, if an insufficient amount of material is unloaded, or if it has to be redistributed by hand.

Unloading Rails—Unloading rails by hand, especially from stock cars, is slow and laborious. This fact, as well as the danger of rails breaking in cold weather, has led to the development of several ingenious methods of unloading rails. When unloading from flats in warm weather many track men consider it safe to shove the rails over the edge of the cars, using a gang of 2 to 4 men with rail forks, or 8 to 14 men with shovels. This method should not be used in the winter time when the rails are cold and brittle and the ground is frozen hard. Under these conditions, skids, a rail derrick, or some other means should be used.

Rail Derrick—For unloading heavy rails portable derrick attached to the sides of cars have been used. Six men only are required, and rails can be unloaded at the rate of one per minute. The derricks are light and can be easily transferred from car to car. They are set up in the stake pockets.

Air Unloaders or Rail Derricks—Recently air unloaders or rail derricks, have been experimented with for unload-

Fig. 2.—Improvised Rail Derrick with Old Rails for Boom.

ing rails and good results reported. Several cranes used with one locomotive and train crew have made records both for speed and low cost of unloading.

Unloading Rails from Flat Cars—When flat cars are used, the rails are sometimes hauled off the rear over dollies, using cables as described below under V-frames.

Mr. A. M. Clough, in the Maintenance of Way Bulletin, March, 1913, described a very ingenious arrangement of skids for unloading rails and also an improvised derrick for loading. The derrick was built of parts of an old

wrecker fitted with an extension boom of two 30 ft. rails. (Fig. 2.) This machine takes care of all rail loading and unloading on the division. A loading speed of 4 rails per minute can be attained.

Skids—The skids for unloading fit into the car pockets in the ordinary manner, and reach clear across the adjacent track. (Fig. 3.) The skid rails are chained together and the front skid is chained to the car ahead of

Fig. 3.—Ingenious Use of Skid Rails.

the one being unloaded in such manner that the skids are dragged along perpendicular to the car, when the train moves. The skids slide on the rail, and require no attention when the train moves. When necessary to clear the track, which is protected by flagmen, the skid rails are uncoupled, the car is moved ahead, and the skids swing around clear.

To retard the speed oak strips are bolted along the sides of the skids and are made to project high enough to retard the rail. As the wood wears off, the strips are

raised a little, the bolts being in slotted holes which allow of this adjustment.

V-Frames—A V-Frame is made by bending a short rail in the shape of a V, after removing about 12 in. of the web and flange at the middle. The outer ends are bent

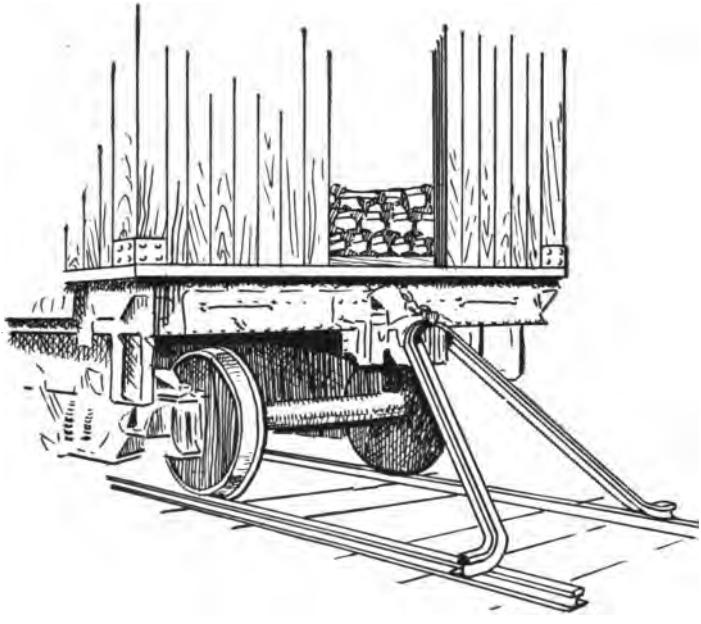

Fig. 4.—V-Frame for Unloading Rails from Stock Cars.

horizontal so they will rest on the track rails, and the V is inverted and placed in position on the pin in the draw bar, as shown in Fig. 4. Two plates are riveted on the bases of the V rail to form shoes which slide on the track rails. The knuckle is removed from the coupling and a round pin with a high head is inserted to hang the V on. The

V-frame is used for unloading out of the end doors of stock cars, or off the ends of flat cars.

Two wire ropes or rope cables are provided, about 20 ft. long, each having a hook in one end to insert in the bolt

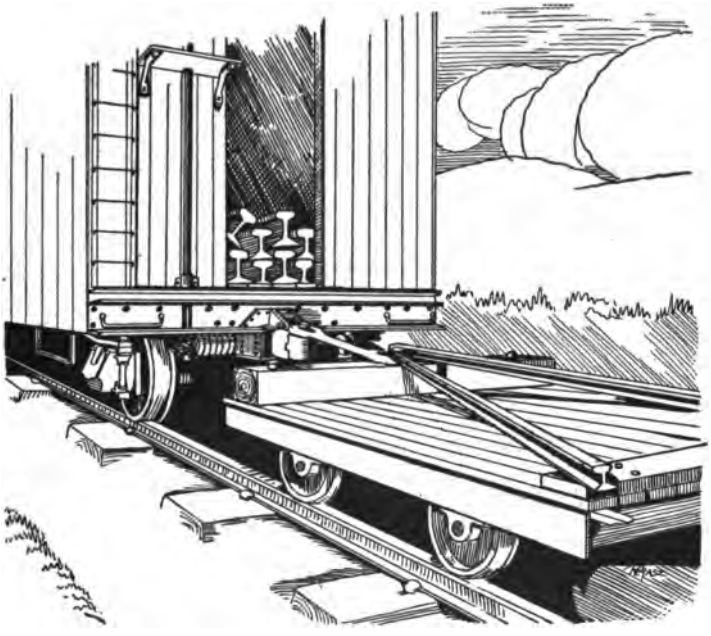

Fig. 5.—V-Frame Mounted on Dumpy.

hole of the rail, and a loop, or preferably a clamp, in the other end. The hooks are inserted in two rails, and the rope may be anchored by means of bars, stuck through the loops and driven into the ground back of a tie, outside of the rail; clamps which will catch the ball of the rail are much easier to use, however. When the train starts, the two rails are dragged out of the car toward the opposite sides of the track. When the end of the rails

next the car fall, they slide down the V-frame and outside the track. The train then stops, backs up a little, and the operation is repeated. Two men are required for the anchor (lining) bars, or clamps, 6 in the car, and 2 straightening up the rails.

Fig. 5 shows a V-frame of a little different type, mounted on a dump car which is coupled to the stock car by a long coupling bar.

Four cables may be used, two of them being 33 ft. longer than the others. The cables can then be anchored at alternate rail lengths and the distribution made correctly without backing up. The train is stopped just before the first pair of rails has fallen, to give time to fasten the hooks in the next pair of rails. The first pair of rails will drop after the train starts again and has moved 3 or 4 ft. and the other two rails will be started and dragged out 25 or 26 ft., at which time the train again stops.

Placing Rails—The advantage of accurate distribution of material can hardly be overestimated in relaying track. While waiting for trains, when distributing material, the gang should be kept busy setting up rails end to end to insure correct distribution; and the joint ties can be distributed just where they are likely to be needed, during such intervals. The time between trains, which otherwise would be wasted, is thus used to place the material so that track laying will be facilitated.

Distributing Ties.—The tables given have been worked up to give figures which can be used in distributing material by noting either the telegraph poles or the rail joints, for either 30 or 33-ft. rails. The figures in most cases have been carried out only to the nearest quarter keg, box, etc., so that they can be easily used by men who are not used to handling fractions.

Table 1 is for distributing ties for a new track. It is customary to take out several carloads at once and distribute the gang on the various cars. The train is generally moved about one train length for each spotting. When spotting according to rail lengths a man may be sent ahead to make a chalk mark on the rail joints at intervals which gives the nearest equivalent to the train length.

The number of ties to be unloaded from between

TABLE 1: DISTRIBUTING TIES ACCORDING TO TELEPHONE POLES.

	30-ft. Rails		33-ft. Rails	
No. per rail Length	Telephone Poles 150 ft. Apart	Telephone Poles 200 ft. Apart	Telephone Poles 150 ft. Apart	Telephone Poles 200 ft. Apart
15	75	100	....	.....
16	80	107	....	.....
17	85	114	78	103
18	90	120	82	109
19	95	127	87	115
20	....	.....	91	121
21	....	.....	96	128

telephone poles for various spacings can be determined from Table 1. The table is not directly applicable to the distribution of ties for relaying. It is rather general practice to provide new ties for every joint, and the distribution is then made on that basis; then, if it is unnecessary to replace all of the joint ties, the new ties can be kept for ordinary renewal near the same location.

Possibly the best method of distributing ties for relaying (unless some parts of the section need more renewals than others) is to count the number of ties and distribute the same number at each rail length over the entire section. Or the number per telegraph pole may be computed and that number thrown off one at a time at approximately equal intervals between the poles.

Distributing Angle Bars.—Table 2 gives the number of

angle bars required per rail length, and per telegraph pole whether located 150 ft. or 200 ft. apart. It is sometimes easier to gage the distribution by telephone poles than by rail lengths, but if the rails have already been distributed, the best method is to throw off four angle bars and two joint plates, or two joints, for each rail length. It is not necessary to distribute extra pieces,

TABLE 2: DISTRIBUTING ANGLE BARS OR JOINTS.

	Per Rail Length	Per Telephone Pole 150 Ft. Apart		Per Telephone Pole 200 Ft. Apart	
		30-ft. Rail	33-ft. Rail	30-ft. Rail	33-ft. Rail
Angle bars.....	4	20	18*	28	24**
Joints (or joint plates for angle bars).....	2	10	9†	14	12††

*2 extras at every 10th pole.
†2 extras at every 20th pole.
**2 extras at every 8th pole.
††2 extras at every 16th pole.

because these appliances are not so easily lost as spikes or bolts.

Distributing Track Bolts.—Table 3, for the distribution of track bolts, gives in its various columns the number of joints which one keg will full-bolt for either 30 or 33-ft. rails, and for either 4-hole or 6-hole joints. For instance, if 4¾-in. by 1-in. bolts are to be used on 100-lb. 33-ft. rails with 6-hole angle bars, column 2 (below) in the table shows that there are 109 bolts to the keg, and column 3, that these will full-bolt 9 joints, and column 4, that it will bolt the joints between 2 telephone poles 150 ft. apart, or column 5, 1¼ telephone poles 200 ft. apart. In making the distribution it is impossible to divide up the kegs, so that with telephone poles 150 ft. apart, one keg should be thrown off at intervals of two telephone poles. For telegraph poles 200 ft. apart, one keg should be thrown off at every pole, and one extra keg at every

TABLE 3: DISTRIBUTING TRACK BOLTS.

4-hole Joints—One Keg Will Full-bolt.

Kind	No.—Per 200-lb. Keg	Joints	33-ft. Rails: Telephone Poles 150 Ft. Apart	33-ft. Rails: Telephone Poles 200 Ft. Apart	30-ft. Rails: Telephone Poles 150 Ft. Apart	30-ft. Rails: Telephone Poles 200 Ft. Apart
¾ in. x 3½ in.	255	31¾	7	5¼	6¼	4¾
¾ in. x 4 in.	237	39½	6½	4¾	5¾	4¼
⅞ in. x 4 in.	168	21	5¾	3½	4¾	3
⅞ in. x 4¼ in.	162	20¼	5½	3¼	4	3
⅞ in. x 4¾ in.	141	16½	4½	2¾	3½	2½
1 in. x 4¼ in.	119	14¾	4	2¼	2¾	2¼
1 in. x 4½ in.	114	14	3¾	2¼	2¾	2
1 in. x 4¾ in.	109	13½	3¾	2¼	2¾	2
1 in. x 5 in.	106	13	3½	2	2½	1¾
1 in. x 5¼ in.	103	12¾	3½	2	2½	1¾
1 in. x 5½ in.	100	12½	3¼	2	2½	1¾
1 in. x 5¾ in.	98	12	3¼	2	2¼	1¾
1 in. x 6 in.	94	11¾	3¼	1¾	2¼	1¾
1 in. x 6¼ in.	91	11¼	3	1¾	2¼	1
1 in. x 6½ in.	87	10¾	2¾	1¾	2	1

6-hole Joints—One Keg Will Full-bolt.

Kind	No.—Per 200-lb. Keg	Joints	33-ft. Rails: Telephone Poles 150 Ft. Apart	33-ft. Rails: Telephone Poles 200 Ft. Apart	30-ft. Rails: Telephone Poles 150 Ft. Apart	30-ft. Rails: Telephone Poles 200 Ft. Apart
¾ in. x 3½ in.	255	20	4½	3½	4¼	3
¾ in. x 4 in.	237	19¾	4¼	3¼	3¾	2¾
⅞ in. x 4 in.	168	14	3	2	2¾	2
⅞ in. x 4¼ in.	162	13½	2¾	2	2½	2
⅞ in. x 4¾ in.	141	11¾	2½	1¾	2¼	1¾
1 in. x 4¼ in.	119	9¾	2	1½	2	1½
1 in. x 4½ in.	114	9½	2	1½	1¾	1¼
1 in. x 4¾ in.	109	9	2	1¼	1¾	1¼
1 in. x 5 in.	106	8¾	1¾	1¼	1¾	1¼
1 in. x 5¼ in.	103	8½	1¾	1¼	1½	1¼
1 in. x 5½ in.	100	8¼	1¾	1¼	1½	1¼
1 in. x 5¾ in.	98	8	1¾	1¼	1½	1
1 in. x 6 in.	94	7¾	1½	1¼	1½	1
1 in. x 6¼ in.	91	7½	1½	1¼	1½	1
1 in. x 6½ in.	87	7¼	1½	1	1¼	1

Sizes of Bolts to go with Plain Bars of the Following Sections:

45 to 67 lb.	70 and 75 lb.	80 and 85 lb.	90 and 100 lb.
3½ x ¾ in.	4 x ¾ in.	4¼ x ⅞ in.	5 x 1 in.

Sizes of Bolts to go with Patented Joints:

	45 to 67 lb.	70 and 75 lb.	80 and 85 lb.	90 and 100 lb.
Continuous	¾ in. x 3¾ in.	⅞ in. x 4 in.	⅞ in. x 4¼ in.	⅞ in. x 4¼ in.
Bonzano	1 in. x 4¼ in.	1 in. x 4¼ in.	1 in. x 4½ in.	1 in. x 4½ in.
Wolhaupter	1 in. x 4¼ in.	1 in. x 4¼ in.	1 in. x 4½ in.	1 in. x 4½ in.
100 per cent	1 in. x 4¾ in.	1 in. x 5 in.	1 in. x 5¼ in.	1 in. x 5½ in.
Weber	1 in. x 5¾ in.	1 in. x 6 in.	1 in. x 6¼ in.	1 in. x 6½ in.

fourth pole. The kegs should be rolled off the car endways; if they hit on the sides they may run down an embankment into the ditch.

Distributing Nut Locks.—Nut locks are usually furnished in boxes of 1,000. Table 4 gives the number of joints, measured by telegraph poles, for which one box will provide nut locks, the left half for two 4-hole joints requiring 8, and the right-hand half for two 6-hole joints

TABLE 4: DISTRIBUTING LOCK NUTS.

		Nut locks—1,000 in a box—one box will furnish nuts for					
		4-hole joints—8 nut locks			6-hole joints—12 nut locks		
		Joints	Telephone Poles 150 ft. Apart	Telephone Poles 200 ft. Apart	Joints	Telephone Poles 150 ft. Apart	Telephone Poles 200 ft. Apart
33-ft.	rail....	124	27½	20½	83	18½	14½
30-ft.	rail....	124	25	18½	83	16½	12½

requiring 12. A few nut locks are likely to be lost, so it is advisable to disregard the fractions (for instance, in columns 3 and 4, top row of figures) and to unload a box of nut locks every 27 telegraph poles 150 ft. apart, or every 20 telegraph poles 200 ft. apart. Where poles are only 100 ft. apart, the amount of track material to be unloaded will be one-half of that for the 200-ft. spacing.

Distributing Track Spikes.—Table 5 gives the number of track spikes, of the sizes commonly used, in an average keg of 200 lb. The number of rail lengths which one keg will full-spike is shown in columns 4 to 10, inclusive. This is for building a new track. For relaying it is the practice to provide new spikes for only part of the work and to require the gangs to use many of the old spikes, so for relaying it is best to make the distribution in the same way as for ties—to count up the number of kegs and distribute them at equal intervals. If, however, it is planned

to provide all new spikes except for the one row which was left in the ties, one keg will spike a third more rail lengths than is given in the table.

Simultaneous Distribution.—For relaying, the cheapest and best way to distribute the joint ties, spikes, angle bars and base plates or joints, bolts and nut locks, is to make up a train to do all this work at once. With careful work it is possible to make all this distribution without stopping, with the train traveling at a speed of 8 to 10 miles an hour. The cars of ties should be placed in the rear to reduce the damage of a possible derailment

TABLE 5: DISTRIBUTING TRACK SPIKES

Size, Length Measured Under Head	Average No. per Keg of 200 lb.	Rail Used, Weight per Yd. lb.	One keg will full spike-rail lengths						
			15 ties per rail	16 ties per rail	17 ties per rail	18 ties per rail	19 ties per rail	20 ties per rail	21 ties per rail
5½ in. x ⅝ in.....	300	75 to 100	5	4½	4¼	4	3⅞	3¾	3½
5½ in. x ⅞ in.....	375	45 to 75	6¼	5¾	5½	5	4¾	4½	4⅜
5 in. x ⅞ in.....	400	40 to 56	6½	6¼	5¾	5½	5¼	5	4¾

resulting from the ties falling on the track. The writer has used this method many times, however, without a single derailment.

Sometimes it will be policy to include the joint ties in the general tie distribution and wait until after rail is relaid to make tie renewals. In this case the section foreman will probably distribute the ties where needed previous to relaying.

Operations in Relaying—A competent foreman should be placed in charge of relaying. Good gang organization is necessary because the work must be done in a limited time and traffic must be maintained. Relaying requires

the following operations: (1) The old rail must be loosened and thrown off its seat before the new rail can be placed; (2) every tie must be carefully adzed where the base of the new rail is to lie; (3) the new rail must be put in, bolted and spiked.

The successive steps in relaying must be accomplished expeditiously and the gang should be so organized that the gap between unspiked old and new rail be as short as possible, depending on the size of gang. Since the time during which the track may be used for the actual work of relaying is limited, everything possible should be done beforehand to reduce or expedite the work to be done after the track is cut.

It is very essential that laborers work rapidly while the track is open. By marking off a certain amount in the morning and giving the men to understand that the day's work is done when they reach that point, or by allowing a rest after track is connected up for a train, the amount of work done may be increased materially.

General Methods of Relaying—Three general methods are used in relaying, which are briefly as follows: (1) A string of rails as long as can be laid in the time available between trains is bolted together on the outer ends of the ties before the track is cut; when traffic allows, the spikes are drawn from the old rails, a joint is broken, the string of old rails is lifted over the new ones and thrown out by the liners, the intermediate joints being disconnected at leisure; the new string of rails is lined over in place and then spiked. (2) The old rail is thrown out and the new rails set up one at a time by the rail gang, then bolted and spiked. (3) The rails are laid on their sides on the ties with ball toward the old rail; the old rail is thrown out and the new rail rolled over into place.

The two disadvantages in using method (1) are that it is difficult to keep the joints in their proper relative positions and to keep the expansion right (trouble with expansion is most serious on curves, because one side is thrown inward and tightened up and the other is thrown outward and loosened up); and ballast is carried in between the rails and ties, preventing a solid bearing. The first method has the advantage of reducing the time the track is held open, but the amount of preliminary work is greatly increased.

Method (2) does not have the objectionable features of method (1) and in general produces better track; most track men now prefer to set the rails in separately, rather than to string them out. In method (1) the force may be organized to swing out both sides of the track, or if the force is not sufficient, one side only may be put in, doubling back to finish the opposite side. It is realized that the latter method will not reduce the number of men one-half, as the distance covered laying one rail should be twice as great, requiring nearly the same number. However, it will be found to result in some reduction in the number of men. A small gang, or plenty of supervision with a large one, is a necessity in relaying track, as all laborers must be kept under close supervision to perform good work.

The rails should be relayed against the current of traffic. In laying with the current of traffic, the train which is flagged tends to destroy the expansion because the air-brakes are applied on the new rail. Two stops have to be made by the train, one where the flagman is stationed and the other where the work is being done. Under these conditions, especially where rail anchors are not immediately applied, the expansion will be spoiled

despite the greatest care in placing expansion shims and the use of the rail thermometers. On the other hand, if the rail is laid against the current of traffic, all the trains are stopped on the old rail and the expansion of the new rail can be kept more uniform.

Modifications of Methods (1) and (2)—Methods (1) and (2) can be modified, according to the size of the gang available; as follows: Method 2-A—Setting in one rail at a time, working both sides of the track; this requires a large gang; method 1-A—Lining in previously connected rails, both sides of the track at one operation; method 2-B—Setting in rails one at a time, on one side only; the gang required is nearly as large as that required for method 2-A; method 1-B—Lining in one side at a time, with rails previously connected; this method requires the smallest gang.

The third organization (2-B) will usually permit the foreman to oversee nearly all the details of the work himself. It is important that only short stretches be laid alternately on each side, by this method, otherwise there is danger of the rail joints getting badly out of correct relative position.

In method (3) the rails are laid on their sides on the ties just outside of the track rails. The old rails are thrown over the new ones when putting in steel, and but two men are required to tip the new rails into position. This is an especially good method to be used with a small gang where trains are very frequent, as it reduces the number of men necessary to have when actually laying rails.

At times during the day when rails cannot be laid on account of trains, the time can be spent adzing ties and jointing up track.

A number of railways have discontinued spacing or slot

spiking at joints, using enough rail anchors to prevent rail creeping. This method has many staunch advocates and bids fair to become standard practice.

Preliminary Work—The shoulders on the ties are adzed down at the inside of one and at the outside of the opposite rail. The claw bar men precede the adzers, and draw as many spikes as is considered safe. Care should always be taken to leave the ties which are left to hold the track to gage, fully spiked on both rails. Failure to observe this rule on curves is likely to cause a wreck on account of the track spreading, as the ties will move endways in the ballast, being spiked on one end only. Unless the weather is very hot, it is usually safe to pull two-thirds and sometimes three-fourths of the spikes. If the track is only quarter spiked, trains should pass at slow speed, and it is well to maintain an order that all trains should be brought down to moderate speed in territory where rail is being relayed.

No adzing is necessary on the outside of the line rail unless tie plates are to be applied, and the new line rail should be set up against the old row of outside spikes. Then the line of the ties will be preserved and new ties may be easily lined up with the old ones.

Pulling Spikes—It is in general considered the better practice to pull the inner line of spikes when relaying rails of the same size as the old. When heavier rail is being used the outside spikes of one rail should be pulled and the inside spikes of the other. Where the rail is so large that three rows of spikes must be pulled, it is better to pull all of the spikes out of the inner rail, on curves, leaving the outside spikes on the outer rail. It is customary to lay the larger base rail by pulling only two lines of spikes, one on the inside and the other on the

outside of the rail; later, the third row of spikes is pulled and the track is gaged by a small gang. When carrying on the work in this manner, the head gang of spikers should drive only a few spikes on the gage rail, as they not only must all be pulled again but the extra spike holes injure the ties.

During preliminary work all spikes should be removed from joint slots, as they are frequently very hard to pull and cause delay if left until setting up rails. Two men should follow the spike pullers with a spike punch and spike maul, and drive down all stubs. When drawing spikes, a full row should be left on one side of each rail, the old rail being slid out and the base of the new one slid under the heads of this row of spikes.

Method 2-A—At the time of actually laying rail, a gang of 56 men could be organized as follows, subject to variations, depending on the size of the rail, etc.

Flagmen	2	Strap hangers	2
Head spike pullers	6	Bolt tighteners	4
Hammer men	2	Spikers	6
Head liners	6	Back liners	2
Head adzers	6	Tool man	1
Back joint spike pullers	1	Assistant foremen	2
Back adzers	2	Foreman	1
Steel gang	12		—
Expansion shim man	1		56

The gang works in halves, one half on each rail, with the exception of the steel gang and the head lining gang, which perform the work on both sides. The spike pullers draw all the spikes left in the preliminary work on the loosened side of each rail. The two hammer men drive the claw-bars under the heads of those spikes which the bars cannot grip unaided. If first-class claw-bars are furnished, fairly expert men will seldom need the assistance of the hammer men. If, on the other hand, poor

claw bars only are available, six hammer men may be required instead of two, and even then the spike pulling will probably be slowed up.

The liners throw the old string of rails off the ties on either side. One man places a pinch bar under the base of the rail on the side from which the spikes have been pulled, and raises the base of the rail up so that it can be slid out from under the spikes without displacing the ties. On the side of the track from which the inside row of spikes was removed, the rail must first be moved inwards to disengage it from the spikes and then lifted over the spikes.

After the rail is removed, the head adzers complete the adzing begun in the preliminary work. The ties should be adzed low enough on the inside to have the rails set vertical or even canting slightly inward, as the rail tends to cant outward in service.

A back spike puller (who pulls spikes where the new joints will come) and two adzers follow the liners. The back-adzers provide a wide bearing on the ties where the new joints are to fall. It is generally easy to determine which are to be the joint ties a rail length in advance of the rail gang, by counting off each time the number of ties per rail length. If the spikes are not pulled on these new joint ties the joint cannot be forced to gage, since the angle bars protrude ½ inch or more beyond the rail base, and consequently would be held out of line. In like manner the spikes which were in the old track joints will stand out ½ in. from the new rails and so they must be pulled also and new spikes driven at such points.

Entering the rails into the angle bars is simpler than when laying track on a new grade, for the ties form a comparatively level surface. The rail gang sets the rail

within 4 or 5 in. of the row of spikes left in the ties, and with one movement slides the rail backward into the angle bars and sideways under the heads of the row of spikes. The work of the strap hangers does not require as much ingenuity as is required in laying new track.

Few spikers are needed at the time track is being laid, only about 4 or 5 ties per rail length being spiked, and it is only necessary to spike these on one side of the rail, the old spikes having been left in on the opposite side. The spikers work singly instead of in pairs.

Expansion—The importance of providing correct expansion when laying rails, cannot be overestimated. If the track is laid too tight, sun kinks will result, particularly if there is an insufficient amount of ballast. If there is plenty of ballast tight track may be kept from kinking to any appreciable amount, but it will frequently show small kinks at joints and the track will appear to be in imperfect line. It is impossible to surface track or line it if it is too tight, for no sooner is the track loosened than it kicks out and it is then almost impossible to get it back where it belongs without cutting rails. It is also extremely difficult to make any changes in such a track, for instance, to put in a switch or to put in insulated joints, which require an extra half inch space for the end posts. In very tight track it is usually advisable to wait until after a switch has all been put in, to measure and cut the pieces back of the frog.

Loose expansion is likely to cause the rails to pull apart in the winter time, leaving a joint so wide open so that it may cause a wreck, and even in the summer the joints may be so wide open that the rails will be battered and spoiled so that it will be almost impossible to keep the joints up to surface. Cars riding over

open joints are subjected to an extra jar which decreases the life of the rolling stock. This damage from poor track is frequently overlooked by railway officials.

Spiking—A foreman can obtain good spiking only by very careful supervision and training of the men. Spikes should always be driven perpendicular to the face of the tie. If driven slanting, their holding power is decreased and they are difficult to pull. Spikes should be driven down so as to give the head a firm hold on the rail, but should not be struck after being snug, as they are likely to crack under the head. The spikes should be staggered—those on the outside of the rail should be near the same edge of the tie, and those on the inside of the rail should be on the opposite edge of the tie. This will keep ties from slewing around or rocking. The usual practice is to place spikes at least 1½ in. from the edge of hewn or sawed ties, and one-fourth of the width of the face from the edge of pole ties. On curves, the best practice is to double spike the outsides of the rails, using tie plates with two holes in each side.

Whipping Spikes—The practice either of "whipping spikes," or bending them and drawing the rail in while driving—is to be severely condemned. It should never be allowed except in places where it is absolutely impossible to force the rail in against the gage with a bar.

Gaging—Track should be gaged at the time of relaying, if there are a sufficient number of men in the gang. However, where time is limited, the gage rail is usually spiked temporarily against the old spikes, and the track gaged later by a small gang which keeps the track safe for traffic while doing the work. Where "base-plates," i. e., joint plates, are used, the track must be surfaced soon after relaying, or else the ties must be adzed for the new plates.

and shims used under the rails where the old plates were. Failure to surface the track shortly after it is relayed will allow rails to become surface-bent.

Supervision—In general, one assistant foreman has charge of the rail gang, and a second assistant is required to oversee the work of throwing the old rail off the ties. Careful attention is necessary to prevent some of the ties being caught on the rail and dragged out of line and surface by a protruding spike-stub, an inadequately adzed shoulder, or by the binding of the spike head on the opposite side of the rail.

Tool Man—The tool man follows the gang and brings up the push car. He removes the expansion shims at a distance not less than about ten rail lengths behind the steel gang, and loads the shims, together with stray tools and excess track fastenings, on the car. If expansion shims are removed nearer than about ten rail lengths from where the steel is being set up, the rails may be driven backwards by the gang setting up steel and in this way the expansion allowance will be taken up and tight track result. On the push car a pair of switch points should also be carried to be used in making temporary track connections.

Flagging—The foreman must properly protect the track by sending out flagmen. He must arrange the amount of work attempted so as to have the track ready for all regular trains, and the work should progress in a manner such as to cause no greater delay than about 15 minutes to extras. These duties are in addition to those of a track foreman on double track work.

Temporary Connection—To make a temporary connection, a joint in the string of old rails is broken and the switch points of the same size and weight as the old rail

are used in the gap formed between the old and new rails. The points should, if possible, be put in "trailing"; that is, the wheels should pass over from heel to point, otherwise there is danger that a sharp flange may force its way between the point and the rail and thus cause a derailment. For a temporary connection to let only one train over, the points can be put in trailing on single track. But where the connection will be used by several trains, some of them will probably run over the connection point-on. A screw clamp has been designed to hold the point rigidly against the rail, and these should always be provided where points are put in track as an over-night connection.

The switch rail should be shortened, to lighten it, and make it easier to apply, by cutting off a piece at the heel, leaving enough rail back of the plowed portion to hold the angle bars. The switch rails should then be drilled; compromise angle bars should be provided and these should be bolted to the switch rail and never taken off—it being merely necessary to loosen the bolts when taking the points out.

Jointing Up—Where slot spikes are depended upon to anchor the rail, the track should be jointed up the same day it is laid. Sometimes this is hardly possible, however, on account of traffic conditions. If track is not jointed up, the rail may run and cause the expansion to be distributed unevenly.

Rail Anchors—Rail anchors, where needed, should be applied the same day rail is laid, for it takes fewer anchors to prevent creeping than to stop it after it has started creeping. Where rails are not anchored at joints it is especially necessary that the rail anchors be applied at time of relaying.

Since the function of a rail anchor is to prevent the

rail from creeping, the first requirement is that it shall be fastened absolutely to the rail. A rail anchor that loosens at all is likely to loosen on account of the rail backing up, this being particularly true when there is frost in the ground and the rail anchor is held by the frozen ground. It therefore seems reasonable to assume that the rail anchor should either be made so that it will prevent creep in both directions, or be provided with some spring appliance which will return the anchor to its original grip after it has been loosened.

So many rail anchors have caused trouble by falling off that it is particularly profitable to keep accurate records of these appliances. Records kept by a number of disinterested, intelligent track foremen will quickly determine which anchor is staying on the rail and really preventing rail creeping. A railway can't afford to buy any anchor which does not hold the rail.

Size of Gang—A relaying gang should number about 60 men, when laying track under this method. The number of laborers is much more important here than in double tracking, because a track being relayed must be in condition for trains the greater part of the time, while in double tracking trains are not run on the part directly under construction. A gang too small to permit the disposing of a sufficient number of laborers on each detail will accomplish less work per man, and the work will be more arduous for both laborers and foreman.

Some types of joints require that the joint ties be spaced before the rails can be bolted up. In that case sufficient men must be delegated to the work of moving ties ahead of the jointers.

Method 2-B—When setting in one rail at a time, one side only, it is possible to reduce the force somewhat, and

a connection can be made more easily and quickly, as only one-half the work is necessary. The difficulty in this method is in keeping joints from running ahead or behind.

If the gang is small, or if there is a shortage of men, this method works out to advantage, for the gang can go ahead a short distance, throw out the rail and prepare the ties for new rails; then they can double back, set up, bolt up, and spike a stretch of track. When the gap is closed, another short stretch on the opposite side may be torn up, or the track may be closed up to let a train by.

Method 1-A—The organization required when lining in previously connected rails, both sides at once, would be somewhat as follows:

Flagmen	2	Spikers	4
Head spike pullers	6	Tool man	1
Hammer men	2	Back liners	2
Head liners	6	Assistant foremen	2
Back spike-pullers	1	Foreman	1
Back adzers	2		—
Lining gang	4 to 6		36
Expansion shim man	1		

Method 1-B—This method, lining in previously connected rails one side at a time, is adapted to a comparatively small number of laborers. The whole gang can go ahead pulling spikes, adzing, and throwing out the old rails on one side, then double back and line in the new rails and spike them in place.

With this method also, it is difficult to keep joints from running unevenly. If one side of the track is not laid further than 6 to 10 rails ahead of the other, however, the joints could be kept even enough. Rails should never be strung out around a curve, as the expansion will be either decreased or increased when the rail is thrown in, due to the lengthening or shortening.

Method 3—The following organization for 35 men has been used by one large railway when laying track under Method 3:

6 adzers.
9 claw bar men.
2 men driving stubs.
16 rail layers.
1 water boy.
1 tool man.

The claw bar men pull two and start the third (outside) spike; each man being assigned every ninth rail, which is marked with chalk, thus making it easy to check up the work of each man. The 16 rail layers lay the rails on the ties with the ball toward the old rail and about 10 in. from it. When relaying, it only requires 2 men to roll the rails in and shove them against the spikes.

In the morning the gang is started out as above and it is said 5,000 to 6,000 ft. of rails may be placed on the ties by 10 o'clock. It is then possible to put in 160 rail lengths in 3 hours on an average day when about 6 connections are made. The flags are sent out at 10 o'clock and the gang rearranged as follows:

2 flagmen.
3 claw bar men.
4 rail liners.
1 assistant foreman.
1 engineer with shims.
1 laborer turning in rails.
2 men holding rails for spikers.
8 spikers.
8 bolters.
2 men making compromise connection.
3 men distributing angle bars, bolts, spikes, etc.
1 water boy.
1 tool man.

The claw bar men pull out the remaining spikes, one man being assigned to pull the spikes at joints and the other two to pull the rest of the spikes on the rail. The engineer carries the expansion shims and places them as the laborers push the rails back. The laborer who works with him has a small bar which he uses to turn the rails up with.

The costs for laying a stretch of 18 mi. where 100 lb.

rail was being put in to replace 75 lb. rail was given in the Railway Age Gazette as follows:

Labor—Foreman, Assistant Foreman and Engineer	$3,066.00
Labor—Foreman, Assistant Foreman and Engineer putting in 14 switches	490.00
Labor—Unloading Material	216.00
Work train, including fuel and engine house expenses	620.00
Total	4,392.00

Per mi. $244.00—Less cost of laying switches and cost of work train—$177.33 per mi. Per ft. .0335.

The average number of feet laid per man per day was 47¾ ft.; the average for 10 hours was 95½ ft. Negro labor was employed and the work was done in the early summer. There were 12 trains from 7 A. M. to 6 P. M. and on the average 8 connections were made every day.

Madden Rail Handling Machines—The Madden rail handling machine consists essentially of a light, but strong steel frame, supporting at the rear end a drum operated by two cranks, upon which is wound the hoisting chain to which the rail hooks are attached. The machine is supported upon wheels designed to run on the track. The two double flanged wheels at the rear are fixed, but the two flat wheels at the front are mounted upon axles which can be swung under the frame when the machine is being used for track laying.

The A-frame supporting the forward part of the machine rests upon the ties when ready to swing a new rail into position, the base of the A-frame resting about 6 in. inside of the rail. A detachable counter balancing lever is provided, having a platform upon which splice bars, spikes, or other track material can be placed to provide the desired counter balancing effect.

When ready to move, two men grasp the handles provided for that purpose and the entire machine is bal-

anced upon the double-flanged wheels and pushed to the desired position. If both old rails are still in place, the machine can be run on the four wheels, either light or carrying a load suspended from the hoisting chain. Three men are required to operate this machine.

The Haddix Rail Handling Machine—The Haddix machine consists of a derrick mounted on a three-wheel car, designed to be operated by a gasoline engine or hand power, as desired. This machine differs radically from others, in that it is designed to operate on the rails which have been thrown out of the track. The three wheels are double-flanged, and the third is free to move in and out on a long axle, as the distance between rails becomes greater or less. The car can be operated as well on a varying gage as on a uniform gage.

If in relaying it is desired to set up both sides at the same time, the car is placed on the old rails which have been moved out to the edge of the ties. If setting up only one side of the track at a time, the third wheel is at such a distance back of the head wheel on the opposite side, that the derrick boom will reach to the middle point of the rail ahead. Thus the car can operate on the old rail on one side, and on the new rails on the other side. The feature of a wheel movable crossways on its axle makes this machine fully adaptable for use under any conditions.

Laying Rail with Locomotive Cranes—The Lehigh Valley has laid a large amount of rails, using a locomotive crane instead of tongmen. On one of these jobs the men were organized as follows:

14 men pulling spikes from old rails in advance of machine.
6 men assisting machine in handling rail (of which one operated the rail clamps, one spiked each end of the rail in place, one forced the rail in against the row of old spikes

with a bar and two men guided the new rail into place, one man at either end).
2 men cut the joints on the old rails at intervals of about 15-rail lengths.
25 men spiked and gaged the new rail.
25 men put on splices.
6 men with picks and shovels moved the ties to clear the joints.

The Lehigh Valley as a result of this experiment has now adopted as standard the practice of unloading all new rails with machines, laying with locomotive cranes, and picking up the old rail by machines the same day it is released. This road has decided that the work is done faster and more economically, with a reduction of interference and delay to traffic.

Cutting Rails—An excellent method for cutting rails is as follows: Chisel mark the rail to a depth of about ⅛ in. on both sides of the web and base (not the ball) with a sharp track chisel. Turn the rail on its side with

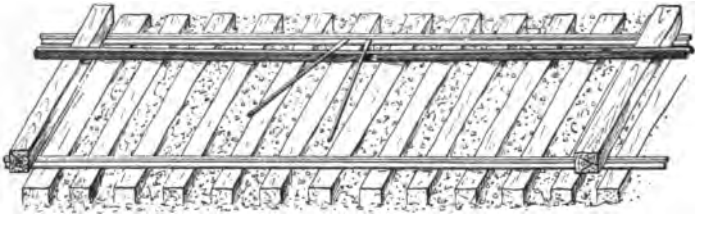

Fig. 6.—Easy and Quick Way of Breaking Rail.

ends blocked up on ties and spring down with bars or by having men stand on it and in the meantime place a chisel in the cut close to the base and strike it with a heavy hammer until a small crack appears in the cut. The rail should then be turned over on its other side and the operation repeated. Finally the rail may be turned ball up and a heavy blow struck on an old chisel held above the cut,

with the men standing on the rail; one blow will usually be enough. The chisel should be held directly above the cut and then a clean, straight break will be made. The chisel cuts should all lie in a plane perpendicular to the axis of the rail, and the cutting chisel should be struck only light square blows or the edge may be broken or chipped.

A fairly good cut can be made as follows: (See Fig. 6.) Cut the top of the flange of the rail on one side, deeply from edge to web, with a sharp chisel. Turn the rail on its side with the cut down, next to a rail on the track and with ends resting on blocks. Four men with bars obtain a leverage under the ball of the rail, and bear heavily on it while a man strikes a blow on the chisel held near the base on the web of the rail, above the cut. When the rail cracks in the cut on the lower part of the base, it is turned on the opposite side and the operation repeated. The rail is then turned ball up and one sharp blow on the chisel held in the cut in the base will usually break it.

Rails cut in the first way mentioned often show a smoothness of face rivaling that of a sawed rail. An older method of breaking a rail was to chisel mark the ball in addition to the web and flange. A short piece of rail or "dutchman" was placed under the cut, one end of the rail was lifted high off the ground by a number of men, and allowed to drop. The last method has the following disadvantages: (a) It exposes men to the danger of being caught under the falling rail and injured; (b) it requires more cutting and therefore more time; (c) it requires more men; (d) it does not produce as clean a break. The ease with which a rail breaks depends not so much on the depth as on the straightness and sharpness of the grooves cut in it. If the rail

is hot the process of cracking may be facilitated by chilling it with cold water at the point where the rail is chisel marked.

For cutting a short piece, say 6 ins., off the end, the rail should be marked as described above. It should then be turned ball down, the chisel placed in the cut in the base directly above the web and the cutting continued until the rail finally breaks. Or one of the new type rail benders may be used to break the short piece off.

The use of hack saws for cutting rails is becoming common. Several hack saw machines are on the market, which eliminate the disadvantages of the old hack saw, that is, breaking of blades, slow progress, poor cuts, and back breaking work. The Schmidt hack saw, it is claimed, will cut an average weight rail in about 40 minutes. The tool is handled by one man and the labor cost is not any more and probably less than cutting a rail with a chisel, which takes at least two men. There is great advantage in using one of these machines, particularly with a poor class of labor.

Curving Rails—The American Railway Engineering Association recommends that rails should be curved for all curves of 2 deg. or over. If rails are spiked on a sharp curve without previously curving them, it will be almost impossible to keep them in line as they will tend to straighten out in the track. The heavy rail sections which are now used make curving even more imperative than formerly. The natural tendency of a rail is to lay straight and that is the reason that curved tracks should always be laid with broken joints, especially if the rails have not been curved, then the centers will tend to move inward and this tendency will be resisted by the joints opposite, which tend to move outward.

Rail Benders—The roller rail bender is generally used for curving rails. A common type of bender consists of two rollers which are placed on one side of the rail and a third roller which is placed on the opposite side. The roller can be turned by a long lever operated by a number of men or by a horse; or it may be moved along the rail as it is being bent.

Widening of Gage—As in curve elevation, opinions regarding the widening of gage on curves have changed radically in the last few years. It is no longer deemed necessary to widen the gage under four degrees and many engineers are not widening the gage on curves of less than eight degrees. The tendency of wide gage is to cause excessive wear on the rails. A table is given in the Appendix showing the amount of widening which the American Railway Engineering Association recommends for curves of different degrees.

CHAPTER VI.

BALLASTING AND SURFACING.

"There are three fundamental operations in maintaining track: Maintaining gauge, maintaining surface and maintaining line. These various operations must be carried on in a definite way, and while the forces tending to hold the track to gauge, surface and line, and the various appliances, are more or less interdependent, the fact remains that the track must first be brought to gauge, then to surface and then to line. These three divisions or operations cover the major part of the trackman's work.

"Now there are three different situations which arise in maintaining surface or getting a track to surface: (1) a track that has not been ballasted, and which it is desired to ballast and put to surface; (2) a track which has been ballasted and in which the ballast has either worn out or become foul, or in which sags have appeared, and which it is desired to give a general lift out of face, renewing the ballast in whole or in part; (3) the very common operation of simply surfacing, or as we generally call it, 'a light lift out of face.'

"It might be possible, although I do not think it necessary, to make a still further division, namely: 'picking up joints.'"*

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*From a letter to the author from Mr. F. R. Layng, engineer of track of the Bessemer & Lake Erie Railroad.

The writer believes that the big thing in doing any kind of surfacing is to get the scheme of organization right, and the main part of the organization is the manner in which the track jacks are handled, including the number of men assigned to them, the system of organizing the tie tampers, etc. And while the work for doing the three kinds of surfacing mentioned above is different, still as far as the organization of the gang is concerned, it is mainly a difference of quantity of men assigned on different details and not of the system of organization. Where a higher raise is being made, there must be more men filling in and fewer men tamping; but the general scheme of organization still holds good.

Where a raise above 6 in. is being made, it will frequently be necessary to use four jacks, two jacks in the front simply springing up the track to prevent surface-bent rails and to make the work of the regular jacks easier and faster. For raises under 6 in. two jacks will generally suffice unless an unusually large gang is being used. The author believes that the gang should be kept small enough so that the raising can be done by two jacks, because it is very much easier to get a good top on the rail and to use the jacks efficiently so that none of them will be delayed, if only two are used, and the joints and centers raised to the spot so that the jacks will not have to double back to raise centers.

A good deal of time can be saved by raising the track above the spot and dropping it quickly without waiting for the tampers to tamp the tie thoroughly. This method requires good judgment on the part of the track raiser, but it greatly increases the speed of the jacks. In fact, the jacks do not have to be held at all. The jack men,

with a good track raiser, will be signaled to drop the jack just as soon as they get through pumping it up, and when the track raiser becomes able to judge the work of the jack tampers, he can gage his raise so well that there will be little hammering down to be done after the jacks are dropped.

It is the policy of some railroads to raise tracks out of a face each year. It does not seem possible that any ordinary track with a good foundation should require such expensive maintenance. There is always the disadvantage that in raising the track out of a face to care for a few low spots, the solid tamped

Fig. 8—Longitudinal Section of Track on New Grade After Being Used by Construction Trains.

bed under possibly 90 per cent of the rail is being discarded. A raise out of face about once in three years will usually be found advisable in tracks of, say A and B class, under medium and heavy traffic.

Preparation of Subgrade on New Track—When trains run over a track on a level-topped grade before it is ballasted, the ties sink into the dirt several inches, the depth depending on the compactness of the soil, amount of moisture, etc. A longitudinal section would then look something like Fig. 8. Dirt should be leveled off to the bottom of the ties before ballast is applied to such a roadbed. One of two methods may be followed: The whole grade can be cut down to the bottom of the tie and the dirt thrown over the shoulder, or the track can be raised and the

dirt between the ties tamped under ther·. The latter method is usually followed, and leaves the top of the roadbed somewhat like the cross section in Fig. 9.

After the track has been ballasted the center part of the subgrade will continue to settle, so that even if the top is made level before ballasting, the subgrade will gradually assume a trough or dish-like shape. The depth of this trough may easily be from 8 to 15 in. on a subgrade of fairly good material. It is this condition which is often to blame for the frequent raising of track out of face and the application of more ballast, when in reality what the track needs

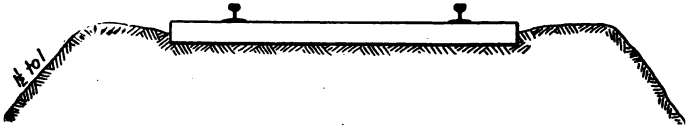


Fig. 9—Transverse Section of Track on New Grade After Being Used by Construction Trains.

is merely drainage. In the recent valuation of railroads many places have been found where the ballast was 4 ft. or more thick, where the track still was settling and where orders were constantly being made for more ballast with which to raise the track.

Since gravel and crushed stone are pervious, rain water soon penetrates to the subgrade and if it is dished, or even if the original depressions made by the ties in the subgrade are left, the water will accumulate and the subgrade will become continually softer. The softening of the grade allows the ballast in the track to settle further and further and the condition becomes continually worse. The water which collects in this manner must soak through the side of

the subgrade before it is rid of. If the surface of the subgrade were higher in the middle than on the shoulders, or even if it were level, the water which penetrates the ballast would find a natural outlet along the top.

It is a good idea to dig down the shoulders of the subgrade 10 or 12 in., just before ballasting, provided the top of the subgrade is dished, thus making a cross section similar to Fig. 10. The dirt obtained in this manner may be used for widening the banks where they are narrow, or can be thrown in between the ties, and the track raised sufficiently to take this dirt, which may merely be tamped with shovel

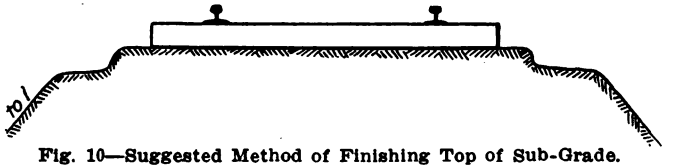


Fig. 10—Suggested Method of Finishing Top of Sub-Grade.

handles. After this is done and traffic is turned on the track for a few days, the subgrade will be in excellent shape for the application of ballast. The final approximate appearance of a cross section after the application of ballast would then be like Fig. 11.

Every precaution should be taken to make the subgrade solid and compact when it is built. Since much construction work is rushed through hurriedly, however, this is not always possible. Where the dirt is dumped off of high trestles it is almost impossible to get the subgrade in good condition for ballast, while in other places the subgrade may be built in the winter and large chunks of frost used. When the frost goes out, of course, such a grade will settle.

The dishing of the grade and its effect have been well recognized by the Baltimore & Ohio railroad, which now requires, as one of its standards, a drain in all double-track, consisting of a line of tile laid in the center of the grade between tracks, with outlets to the ties.

Preparation of Old Grade for Reballasting—Before reballasting an investigation should be made at a number of points, by digging down, to find the depth of the old ballast and the condition of the subgrade. If it is found to be dished badly some provision should be

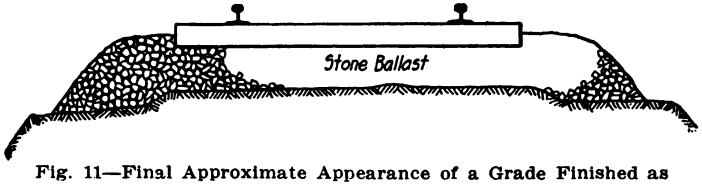


Fig. 11—Final Approximate Appearance of a Grade Finished as Shown in Fig. 10.

made for drainage before placing a new coat of ballast. Many methods have been advocated for the draining of dished or pocketed subgrades. Among them might be named tiling, French drains, pole ditches and ordinary ballast drain ditches. If the ballast is clean, ditches at right angles to the track may be dug down in the shoulder to a depth of about 6 in. below the lowest point of the trough under the track. Such ditches need be made only a shovel width wide and would be effective where the subgrade is not dished more than about one foot. These ditches should be filled with clean ballast.

The Baltimore & Ohio and the Cincinnati Hamilton & Dayton have recently used a spreader for tak-

ing down the shoulder on embankments where the drainage was poor. The shoulders were cut down far enough to make them lower than the trough in the center of the track. The work was done at a very low cost, and has already resulted in a great improvement in the track maintenance on the district subjected to this process.

After subdrainage work has been taken care of, the stripping gang should remove the old ballast to about one or two inches above the bottoms of the ties in the center, sloping out to the bottoms of the ties at the outer end, and off to the edge of the grade; or the sloping from the ties to the edge of the grade may be done by a spreader at considerably lower cost. Leaving 2 in. of old ballast in the center of the track will prevent the ties from moving or twisting until the new ballast is applied.

There is one other explanation for the track settling into the subgrade besides improper design and construction of subgrades. The whole track structure, as it is now built, is being overworked, and in turn, overstresses the subgrade. Part of the solution of this problem is, therefore, the strengthening of the track structure as a whole—the use of heavier rail, more ties, greater depth of ballast and more care in the preparation of the subgrade of the track. On the other hand, it is impossible to rebuild old subgrades. Most of our roads were built for light traffic, and none too well built at that. And since most of the subgrades were poorly built, the biggest part of the problem, after all, is the drainage.

The gang which is stripping out the track should

space the ties and tap down all loose spikes, so that the ties will come up snug to the rail when raised.

Type of Ballast Cars—No matter what type of ballast cars is being used, the foreman should carefully examine the ballast, in case there is likely to be any which is unfit for use; and cars of poor ballast should be switched out before the train starts to unload. Ballast cars may be roughly divided into three classes —center dump, side dump and plow cars. Cars used for plowing are also frequently called side dump.

Wherever the dirt or ballast is stripped out from between the ties, center dump cars will be found to be the more efficient. They drop the ballast in such manner that it can be spread and then put under the track with practically no rehandling. Where the track is not to be stripped out (and this does not happen very often unless a very light raise is being given) it may be impossible in some cases to drop enough ballast in the center of the track to give the desired amount for the raise. In most cases, however, where the raise is high, the dirt or ballast will have been stripped out; and in cases where the raise is low, usually the center dump cars will give enough of a spread anyway. With other methods of unloading, more equipment and the rehandling of the ballast are necessary. An engine, plow and cable are used extensively in ballast work. With this method, as with center dumps, the train can be moved along as it is being unloaded, thus preventing the ballast from piling up and burying the wheels of the train.

The air side dump cars or Lidgerwood and side plow are especially adaptable to making a high fill

where the track may be constantly lined over to the edge of the fill, as the work progresses. Air dump cars, however, cannot be used as standard equipment for winter service, and so they are not used very extensively in ballasting work. The Hart Convertible car can be used either for center dump or for plowing, and is convertible into a standard gondola car, for use in the winter. A great many trackmen favor cars of this type.

Sags—Where there are sags of 6 in. or more in the track which is to be ballasted, these should be taken out before the general distribution of ballast. This will make it possible for the surfacing gang to bring the track uniformly up to the stakes. Raising the sags first also makes it unnecessary to haul ballast through the surfacing gang and distribute it back of them, assuming that the surfacing is progressing toward the gravel pit.

Unloading Ballast—If the ballast is being unloaded from center dump cars, the car at the head end of the train should be opened first and the following ones opened in rotation as required; then the empty cars will not have to run over the track where ballast has been unloaded.

An experienced gang of men should be used on the unloading. Inexperienced men are likely to dump too much in a place and to stall the train or derail the cars. A spreader or track plow should be used at the rear of the train to plow the ballast out over the shoulder, and should throw out enough gravel from the flangeway to prevent stones from being struck by trains. The train should be kept in motion while the

gravel is being unloaded, and not more than two or three cars should be opened at one time. The second car may be opened gradually as the ballast is dumped from the first, the third after the second, etc. By handling this work carefully an even distribution can be obtained.

If no track plow or spreader is available the gravel may be plowed off by using ties in front of the car, piled so that there will be a practically perpendicular face, enough being used behind the front row to solidly brace against the wheels of the car. When plowing off in this manner the wheels of the car will slide and become flat, unless shoes are provided. Shoes for this purpose are made of iron straps about 3 in. by ½ in. in section, bent in a curved form at the bottom to fit the wheels, with a straight vertical leg ending in a hoop which fits over the top tie. The front pair of wheels is pushed up onto these shoes, the shoes sliding on the rail, and thus protecting the wheels. This method of spreading ballast is not to be recommended. Not only does it fail to throw the ballast far enough out, but it does not flange out the track, and it packs the ballast down solidly, so that when raising, the ties are likely to drop off on account of the pressure. Roger Ballast or Hart Convertible cars, used for center dump, have been unloaded for 6 cents per car, for the time actually used in unloading.

Ballast Handling Equipment—Only heavy, well-designed track or car plows and substantially-built spreaders should be used, so that there will be little delay because of breakdowns, plows jumping off of cars, or spreader getting off the track. A powerful locomotive is a necessity for operating a spreader, for

a poor engine will be stalled frequently, and is likely to tie up traffic, besides holding up the work. Spreaders are subjected to particularly rough service in coarse ballast, yet they must keep to the track to give a uniform spread.

On the other hand, there is good reason for ballasting against the current of traffic. Otherwise all trains which are flagged will make two stops on the track which has been newly raised and where the ballast is loose—one stop at the flag and one at the work. This is likely to cause the track to start creeping, whereas, if the stops are made on the old track which has been undisturbed, there will be no likelihood of the track creeping any more than it does under ordinary conditions. Before surfacing the track, a laborer should be sent ahead to tamp down all loose spikes, so that the ties will come up snug with the rail when it is raised. This will save the time and trouble of nipping up the ties for the men to tamp.

When track is surfaced, it should be filled-in immediately and dressed up enough so that water from a rain storm will not penetrate to the subgrade, and thus let the track down.

SURFACING.

Organization—In the organization of a surfacing gang the work should be arranged so that: (1) Laborers will not have to double back, and thus cover an extra amount of territory. (2) Men will not have to pass, but will always follow each other in the same order. In this way time will be saved, while in the tamping good work will be mixed with poor, resulting in a more uniform job throughout. When laborers have to pass each other, as they would, for instance, if each gang of tampers tamped a complete rail length,

there may be a lot of time wasted visiting as the laborers from the back pass the others in proceeding to the front.

With 67 men, the following organization will be found efficient:

1 spot board man.
2 jack hole diggers.
6 jack men.
4 jack tampers.
4 men filling in for jack tampers.
1 hammer man.
1 levelboard man.
8 men filling in.
16 men tamping ends.
8 men filling centers.
16 men tamping centers.

Total 67

General foreman, 1; assistant foreman, 1.

Spotboard Man—The spotboard man sets up the spotboard on the stakes and levels it; or in case there are no stakes, he sets it from sights made by the foreman with his blocks. Two spotboards should always be provided, so that the spotboard man may be setting up one while the foreman is sighting to the one in the rear. A spotboard bracket should be used; it consists of a steel slot with a point, which is driven into the ground; the spotboard rests in the slot at the top, and is thus prevented from blowing over or falling off the stakes.

Jack Hole Diggers—Jack holes should be dug about two ties ahead of the joints and about the same distance ahead of the centers of the rails. Jack holes should always be made level on the bottom and plenty large enough for the jack blocks. If the hole is made rounding toward the ends, all the strain

will come on the end of the jack board, breaking or bending it.

Jack Men—Three men should handle each jack, two of them carrying the jack forward, the third carrying the jack block. An ordinary joint plate makes an excellent jack block, if provided with a handle by twisting wire around through the spike slot holes. Extra jack boards should be provided, so that the man who handles them may move on ahead of the gang and set the plates in advance, while the joint in the rear is being raised.

Jack Tampers—Two jack tampers should be assigned to each jack, so that it will not be necessary for the jack men to drop the handle and do the tamping. The jack tampers should start working just as soon as the men start to raise, so that by the time the raiser gives the word, "High," the tie will be tamped sufficiently so that the jacks may be dropped immediately. It requires both skill and practice for the track raiser to become so expert that he will not raise the joints too high or too low. Once this method is mastered, however, vastly greater progress can be made.

Men Filling for Jacks—Two men should be assigned to each jack, to fill-in ballast for the tampers. The best men, and plenty of men, should be used around the jacks. With a gang organized in this manner, two jacks will raise as much track as a gang of 67 men can finish, when the raise is not more than 6 in.

Levelboard Men—The level man should stay with the jacks and see that both sides are brought up together. If one side of the track is brought up first and tamped, the first side will be raised too high when the

other side is leveled, because the tie will rest on the ballast at its outer end and tip up; also this will leave a space under the tie where there is no ballast. The levelboard man should set the spotboard block for the foreman. Or the level may be trimmed down to the correct height on one side and used instead of a spotboard block.

Hammer Man—The hammer man should carry a wooden sledge and not a spike maul. The track should never be lifted so high that more than one or two blows will be required to bring it down to the spot. The hammer man should carry an extra spotboard block, so that the joint may be sighted and knocked down while the jacks are being moved ahead.

Men Filling Ends—Eight men, four on a side, should fill-in for the tampers. This work should be carefully supervised, as a tie tamped with insufficient ballast represents wasted work.

Organization of Tampers—The tampers should be organized to tamp the track in the following manner: If there are four pairs of tampers on the ends, each side, the head pair should tamp every fourth tie, the next pair the tie behind that, the third gang the next to the last tie, and the last gang the last tie. The center tampers should follow a similar system. Besides keeping the men working close together, without interfering with each other, this method makes it possible to get more work out of men who would otherwise "soldier." And, more important still, the track as a whole is tamped in a more uniform manner. Under the old method, where each pair of tampers was assigned a rail or half-rail length, the sections tamped

by the best tampers stood up better than the rest, and consequently the track settled unevenly and became rough. Where the good tamping is mixed with the poor, the whole track is more likely to settle uniformly.

Center Filling and Tamping—The centers should be tamped about 16 in. inside the rail on low lifts and all the way across on high lifts. The men filling should not be allowed to rob some places of gravel and leave a surplus in others.

Tamping Tools—When the lift is more than 1½ in. it is better to allow for settlement and tamp with shovels instead of tamping bars (except in stone ballast). When the raise is small and the bed is hard, the tamping bar is the most efficient tool; but it is seldom that tamping with bars is profitable in surfacing new track, as the subgrade settles so much that the track will get out of surface, no matter how well the tamping has been done.

Recently tamping machines, which operate by air, have been put on the market and used successfully. There is no question but that they are of exceptional value around interlocking plants, or at other points where it is hard to do tamping with picks.

The Track Raiser—An active man with a good eye makes the best track raiser. He should be careful to sight from about the same distance back of his jack each time, and should raise joints and centers with the spot, thus making it unnecessary for the laborers to double back and raise the centers. In other words, he should raise the joint, then the center ahead to the spot, then the joint ahead, etc.

Foreman and Assistant Foreman—One of the assist-

ant foremen should raise the track and the other should look after the tamping. The foreman should keep a general supervision over the whole work, look after the flagmen, watch the time cards, and see that no part of the work is holding up the gang. If the jacks are inclined to lag, more or better men should be put around them; if the end tampers are holding back the center tampers, the force should be rearranged. The track foreman should constantly be studying out new ways of arranging the men or the work, to lessen the amount of labor necessary in raising a given amount of track. Many foremen hang to the methods which they learned when they were first employed on track, and consequently do not get out as good or as much work as a man who is up-to-date.

Tamping Centers—Track centers must be tamped when making a high lift, and this is especially true of mud or dirt-ballasted tracks. When making a low raise on an old track the centers should be tamped for about 16 in. inside each rail, but not directly in the center of the track, as that is likely to cause center binding. When tamping centers all the way across, the heaviest tamping should be next to and under the rail, but the ballast should be tamped under the center sufficiently to completely fill the space and not leave pockets which may be filled by the first rain. On a bridge approach the track should be raised higher than the bridge. The fill settles and the embankment tends to spread, while the bridge stays up. Such places should be inspected and raised again after each rain, if necessary.

Lining Track—The foreman, in lining track, should

stand with his back to the sun, if possible. For lining out long swings he should stand as far away from the gang as possible, giving his orders entirely by motions. In this way he can line the joints and centers to an approximate line, or if necessary, he can take every fourth or fifth joint and throw this to correct line, and then go back and line the rest of the track to these correct points. In lining out short kinks, where the general line is correct, the foreman should get much closer to the gang, so that he can see the small imperfections.

In lining up-grade the foreman should sight the track from both directions, as this is a point where the line frequently is not good, because the track beyond the summit cannot be seen. The foreman will save a good deal of time by looking at such a piece of track from both directions before he starts work on it. Particular pains are required in lining the points of curves and the adjacent tangent track. The foreman should look at such places from a distance of a quarter of a mile, to be sure that he get the track in correct line.

The policy of leaving long swings in the track, rather than to take the time and trouble to line them out, is to be strictly condemned. The writer knew of an instance where a swing of 6 in. was taken out of a piece of track, it requiring about three-fourths of a day of a large extra gang's time. This track had been gone over by two extra gangs before that time, both gangs having left the swing in the track rather than spend the time to correct it. The foreman who finally took it out got a black mark for spending so much time at lining.

The proper length of string to use for lining curves is 62 ft. long. The deflection at the middle of such a string will be 1 in. for each degree of curve. For instance, on a 6 deg. curve, the rail should be lined within 6 in. of the string at its center. The cord can then be moved ahead a half length, or 31 ft., and another point lined out 6 in. from the center of the string, and so on, all the way around the curve. The parts of the track between these points should then be lined by eye. Many railways are now spiralling or easing their curves, and while many methods have been evolved for determining the points, it is best for the trackman to have the engineer lay out such curves.

Records—Records made in surfacing track are a fine endorsement for a foreman, providing the work stays up, or provided he gets far enough away before it goes down, so that he cannot be held responsible. But low lifts and omitted tamping on a new track simply represent company money thrown away, although the individuals concerned sometimes succeed in attaining their own advancement. This condition would not exist if less emphasis were laid on the number of feet of track raised per day, and more attention paid to the quality of the work. As it is now, many of those in charge of track foremen are concerned only with the amount of track raised, and not with the permanence of the work.

Time to do Surfacing—The author gave some costs in "Practical Track Work," which showed that surfacing done in the spring was twenty per cent cheaper than that done in summer. This was because better laborers were obtainable at that time, the weather was cool, and the ballast was softer and more easily worked.

Another reason why surfacing out of a face should be done as early as possible in the spring is that tie renewals may then be made at the same time. The renewals cannot only be made much more cheaply in this way, but the disturbance of the roadbed is decreased. Further, the ballast has the maximum time to become compacted, before the winter season.

Height of Raise—A raise up to 9 in. may be made in one lift. If more than a 6 in. raise is being made, however, two "swing jacks" should be used in advance of the raising jacks, to spring the track up enough so that the rails will not be surface bent. No tamping is necessary with the forward jacks, as the ballast will run in sufficiently to hold the track up. Where a 12 in. raise is being made there should be two lifts. After making the first lift in stone ballast, the stone should simply be bladed-in clear across the tie and not bar tamped. On the second lift the bars or tamping picks should be used and the centers tamped 16 in. inside the rail. When a raise of 9 in. or over is being made, the track should not be shouldered up until the smoothing gang has gone over the work and picked up the low spots which have developed.

General Notes—When starting a new gang the foreman should be careful to see that the tamping is done right. New men are likely to tamp against the side and not under the tie, particularly if the raise is 2 in. or less. It is difficult for some men to grasp the idea of how to shovel-tamp a tie, and the foreman will have to exercise a good deal of patience in teaching them. It is best to teach by example, the foreman or assistant foreman taking hold of the shovel and making the

motions slowly, so that the green man may gradually learn how it is done.

When filling-in for the tampers, the assistant foreman or foreman should not allow gravel to be taken from a spot where it is short, nor should he allow the men to dig borrow pits. If this work is watched closely and the ballast cast from places where there is too much, to places where there is not enough, there will be little redistribution to make behind the surfacing gang.

The track should be lined daily, before filling centers. If the track is not too tight, it should be lined at night and centers filled in as close up to the front as possible, in order to be prepared for rain. If the track is tight it may be impossible to line the kinks out of it until the following morning, when the rails have contracted.

The track should be dressed, finally, to the standards of the road. A template is a very handy appliance for use in shouldering. It consists of a long plank, similar to the spotboard, which is laid across the track, having depending boards placed at the proper points to indicate the edge of the shoulder, its top and slope. A ballast spreader can also be used for shouldering.

Clough's Method of Stone Ballasting—A. M. Clough, a supervisor of track of the New York Central Railroad, has developed a method of applying stone ballast, which deserves mention here. A separate stripping gang, which keeps a mile of track stripped ahead of the surfacing gang, is used. Enough stone is run in the center of this track to hold the ties to line and to keep them from moving out of place or being twisted;

this is done each morning, or at most, every second morning, so that there is very little stripped-out track ahead of the surfacing gang. The foreman takes out stone enough in the morning for a day's work for the surfacing gang, and after the stretch of track for which stone has been distributed has been raised, the men are through for the day. With this method the trains are operated at full speed over the track being surfaced.

The organization is about as follows:

2 jack hole men.
8 jack men (for jacks).
4 additional men with the jacks.
1 levelboard man.
4 men filling in.
20 men tamping ends.
8 men lining track.
2 water boys.
1 foreman.
2 assistant foremen.

With the head pair of jacks no tampers are necessary, these merely springing up the rails, so that they will not be bent by making too high a lift at one time. The stones are loose and run in under the ties sufficiently to hold up the track. The following jacks raise joints and centers with the spotboard blocks, one joint and one center tie being tamped with the bars and knocked down a little with the sledge. There are two men with each jack, and two additional men for tamping and filling-in, besides the level man. One of the extra men forks-in ballast, and the other knocks down the joint with a wooden sledge. The jacks and the men working on them are in charge of the assistant foreman, who does the raising.

Back of this gang four men fill in the ends with ballast, two men working on each side of the track. The tamping spade, a light and efficient tool for this work, is used and the ballast merely bladed in. Tamp-

ers are arranged in five gangs on each side of the track, each gang being numbered. The half rail lengths ahead of the gang are numbered likewise, 1, 2, 3, 4 and 5, and each gang has to take the half rail marked with its number. In the afternoon the gang runs back over the work, raising any low spots which have developed, and tamping 16 in. inside of the rails on both sides.

An assistant foreman and 8 men are kept lining track all the time. A week after the gang has left the work, the section foreman, with about 10 men, follows and does whatever additional raising is necessary, after which there is a further light dressing of ballast and a final dressing up of the track.

The advantages stated for this method are: (1) The stone is handled when loose, two-thirds of it going to its place by gravity. (2) The men can see the end of the day's work and will work faster making it possible to do a larger day's work. (3) This organization breeds rivalry between the various members of the gang. (4) It gives an easy way of identifying the work of each gang of tampers.

Some criticism of this method has been made, many roadmasters objecting to allowing trains to pass over stripped track at full speed. The writer's opinion is that the method of having each gang of tampers tamp a tie and then skip enough ties for the following gangs, results in more uniform work and better organization.

It is handy to have two rails with the surfacing outfit, about 6 in. shorter than the standard rails, so that in case the track kinks, the short ones can be put in,

in place of standard rails, and there will be no delay to traffic. The standard length rails should be left at that location, so that in the winter, when the track shortens up, the standard length rails may again be put in.

Another Method of Stone Ballasting—The following organization has been used by a prominent trackman:

1 foreman.
1 assistant foreman raising track.
1 assistant foreman lining track.
2 flagmen.
4 jack hole diggers.
13 jack men.
20 tampers.
8 liners.
1 water boy.

There are two such gangs used. The first gang raises the track 1½ in. below the grade stakes, and shovel tamps the ends only. The ties are spaced and renewed where necessary, and ballast is unloaded then from center dumps. Wooden mauls are used for spacing ties. The pressure of the ballast will fill in under the ties and leave enough ballast in the middle of the track for the second lift. This method saves center tamping on the first lift, and also saves the work of filling in.

The second gang follows in from 5 to 7 days to make the final lift. This is pick-tamped, and is raised ½ in. above the stakes, which gives about a 4-in. raise. The centers are tamped about 18 in. inside of the track only.

The spotting gang follows, after several days, and picks up the low spots, which are then tamped in the centers with picks. The finishing ballast is not put on until after the spotting gang has got through, and

there is perfect surface and line. With this method there is only one handling of the ballast—none by hand—except cleaning off the ties which were covered by the finishing train.

To reduce the setting of jacks, when swing jacks are used, the jack men exchange each time, the swing men simply raising up their jacks and leaving them set for the gang of lifters. The lifting gang carries its jacks ahead and exchanges, and the swing gang then moves ahead and makes the next lift.

Tools—Jerry O'Connor, of the Minneapolis St. Paul & Sault Ste. Marie Railroad, recommends that an organization of 50 to 100 men, under the supervision of one foreman, two assistant foremen and one timekeeper, should be provided with six No. 6 Barrett track jacks, two levelboards, and two spotboards.

Plenty of tools should be provided, so that in case the work cannot be opened up rapidly in the morning, or there is difficulty in closing it up at night, there will be plenty of shovels, so that all the men may dress or fill in. And when there is a train coming, and it is necessary to tamp up the track quickly, there should be tamping bars or picks enough for the gang. The foreman should take good care of his tools, and not leave them scattered back of the gang, as this is likely to result in losing them. For a big gang a tool man is a good investment.

CHAPTER VII.

REPORTS AND ACCOUNTS.

A foreman should take pains to make out his reports, time books, etc., correctly and plainly, for his ability to hold higher positions is often judged from them. We give herein a general discussion which will give the track foreman a better understanding of the various systems followed. Further, the information may prove valuable to the trackman who accepts a position with another road.

Semi-monthly reports on time are a recent development made necessary by state laws, which require railway employes to be paid twice a month. In some states payments are even required to be made four times a month, in which case the railroads of necessity require a weekly time report.

A number of factors have arisen in the track field which have recently led to careful consideration of the reports which the trackman is required to make out. In the first place, the Interstate Commerce Commission now requires railroad expenses to be reported to them under carefully defined headings, and in order to get these direct from the track foreman's report, some railroads have entirely changed their forms.

Another reason for changing report forms is the advent of the foreigner as a track foreman. Many foreigners, who are first-class track men, have not had enough schooling to enable them to make out an elaborate or complicated report with any degree of accuracy. The reports for these men must, in general,

be simple enough so that they can be easily understood and as easily made out.

Getting Assistance—It is usually possible for the track foreman to obtain the assistance of the station agent or operator to help him make out his reports—to explain to him anything which he does not understand thoroughly. If the assistance of these men is not obtainable, there will usually be someone who can help the track foreman out.

Kind of Reports—The original method on practically all railroads was to have the track foreman make out his report of the amount of work done, time of laborers and distribution of work once a month, in a monthly time book. The many variations of this methods are described below.

Recently a number of railroads have discarded the monthly time-distribution book, and adopted the practice of having all the information sent in daily. The foreman makes out his report for each day, when the whole thing is fresh in his mind, and his responsibility ends. The rest of the work is done in the office of the roadmaster or supervisor.

Advantages and Disadvantages—The disadvantages of the monthly system are that it piles the work up on the foreman, who is compelled to work far into the night toward the end of the month, in order to get his books in shape and checked up, so that he can send them in on time. The advantages of the system are that if the time books are correctly made out and balanced, there is very little further work to be done on them in the office of the roadmaster or supervisor.

With daily reports, the work of the foreman is greatly reduced, and his responsibility for the work

done during each day, ceases at the end of that day. He is able to make the entries on his report while the work is still fresh in his mind, and he is, therefore, more likely to get them accurate. This refers particularly to the distribution of the time of the laborer. When using the monthly report, there is a great temptation for the track foreman to put off the distribution of the time for days, or sometimes weeks, and then try to make it all up from memory; this results in inaccuracy.

Recent Changes—A good many railroads have recently adopted the daily report. The officials of these roads are satisfied that in this way they get much better reports and much better recapitulations than they did under the old system. Moreover, a good many roads are beginning to think that the track foreman has enough duties in keeping his track in surface and line, and being responsible for it 24 hours in the day, without having to do additional clerical work.

Some roads have recently changed the track report forms, in order that the data desired for reports to the Interstate Commerce Commission may easily be obtained direct from them without any figuring.

Methods Now in Common Use—A survey of present practice on a number of roads shows a variety of requirements. The oldest type used is the monthly report on both time and distribution, such as is in use on the Canadian Pacific, Chicago & North Western, Chicago Milwaukee & St. Paul, Illinois Central, Nashville Chattanooga & St. Louis, Northern Pacific and Southern Railway, all of these roads having modified and improved their forms to better fit conditions as they now exist. A semi-monthly time report and

monthly report on distribution are required by the Chicago Great Western, Erie, Pennsylvania, Wabash, and other railroads. Semi-monthly reports on both time and distribution are in use on the Minneapolis St. Paul & Sault Ste. Marie and others.

A number of roads require weekly reports of the time of the men and monthly reports on distribution, among which are the Chicago Rock Island & Pacific and the Chicago & Alton. The Missouri Kansas & Texas, the Southern Pacific and the Norfolk & Western require daily reports of the amount of time worked by the gangs, and monthly reports of distribution. The Atchison Topeka & Santa Fe requires semi-monthly reports of the total time worked, and weekly reports, showing the kinds of work which have been done. Still other roads require a weekly report of the complete time of laborers and a daily report of distribution.

One of the latest developments is daily reports. On the Baltimore & Ohio, Cincinnati Hamilton & Dayton, Cleveland Cincinnati Chicago & St. Louis, Delaware & Hudson New York Central and the Pennsylvania Railroads a complete report is required daily, both of the total number of hours worked and of the distribution. When these reports are made out each night the foreman's responsibility ceases, the remainder of the clerical work being done in the office of the supervisor or roadmaster, the division engineer or superintendent.

PRESENT PRACTICE.

Monthly Reports—The Canadian Pacific is typical of the roads which require monthly reports on both the time of laborers and distribution of work. The

roadmaster is expected to keep in touch with the work, so that he can check up fairly well both distribution and time, as sent in by the foreman, and the officials consider that this system does away with unnecessary daily or weekly reports. A tie report, rail fastenings report, rail report, tool report and material report, are required once a month. These blanks are made as simple as possible, but very much in detail, so that there is no possibility of the track foreman omitting anything. The men are educated in filling out these forms, so that no mistakes need be made. The foreman is required to carry his time-roll book with him constantly, and to be ready to submit it for inspection to the roadmaster at any time. The time book is made up with an enclosed carbon sheet, and second sheet, on which a copy is made of the foreman's entries. The foreman cannot get at the duplicate to alter it without tearing the two sheets apart at the bottom and the top. This makes it easy to detect any corrections made. When these are necessary the foreman makes them on the original and either explains them in the column on remarks, or personally to the roadmaster.

The distribution of labor is made on the two last pages of the book, the time being distributed on the basis of a day's work by the full gang, instead of individually for each laborer. Between the distribution section of the time book and the time report section there is a stiff cover, similar to that on the outside of the book, so that there is not much danger of a green foreman getting the two parts mixed.

The Chicago & Northwestern Railway follows a somewhat similar method. The form of the time book has been changed, so that now the foreman distributes

the time of his gang on the basis of a day's work performed by the gang as a whole, instead of making an individual distribution of each employe's time. In the Chicago & Milwaukee terminals the track foremen do not keep time and material reports, this work being performed by a timekeeper, who is assigned to a territory embracing three or four foremen's districts.

On the Chicago Milwaukee & St. Paul, in addition to the monthly report, the section foremen send in daily cards to the roadmasters, showing the number of men-hours worked that day, and the work on which the men were engaged. This information is returned weekly by the roadmasters to the division superintendent, and to the office of the assistant-to-vice-president. The reports of extra-gang foremen to the roadmaster are forwarded to the superintendent, and then to the assistant-to-vice-president, the report giving the number of men worked, the total number of hours, and details of the work performed. The form of time book was changed in 1913, to have the distribution made in line with Interstate Commerce Commission requirements.

The methods of the Illinois Central are similar to those mentioned above. The time books are provided with a carbon sheet, similar to that used by the Canadian Pacific. The time books were designed in this manner for the purpose of promoting accuracy on the part of the foreman in recording time, and to facilitate checking against fraudulent entry. The carbon sheet discloses any changes or erasures made in the time sheet, and such erasure or changing of original entries is prohibited. If a foreman makes a wrong entry an explanation is made by him, and the cor-

rection is made in red ink, either by a time inspector or the supervisor. The material book is arranged so that the material used can be, and it is required to be, recorded each day. This simplifies the report, since the various classes of material may be reported under one head during the entire month, and the entering of items each day eliminates, to a great extent, the possibility of the foreman omitting to report any material used.

The reports on the Northern Pacific have been simplified, as far as possible, to make them most easily understood, and to keep the clerical work of the foreman down to a minimum, and yet get the necessary information. The foreign foreman on this road has been found as capable of performing clerical work as the native foreman formerly employed. The material and tool reports are made as simple as possible, but in sufficient detail to obtain the information required by the Interstate Commerce Commission. A weekly report is required, showing the number of men worked, the amount earned and distribution daily. This report, which is entirely separate from the monthly time distribution reports mentioned above, is required as an expenditure report for the information of roadmasters and superintendents. The foremen are required to keep a record of costs of maintenance per mile, this information being compiled for the roadmasters each month, and sent by the roadmasters to the foremen, so that expenditures can be compared with previous months and years. Expenditures for divisions or for sections can also be compared with others.

On the Southern Railway, time books are sent in

monthly, but the foremen are required to make entries in them daily, except for the record of tools, which may be made monthly. The forms for time of laborers, distribution, tool and material reports are all included within the time book, so that they may be made out with the least difficulty by the foreman, so that he need not keep a supply of loose forms. Until recently the time books were assembled in the offices of roadmasters at the close of each month. Pay rolls, labor distribution, etc., were made from them, by or under the direction of the roadmasters. This system has been simplified, and the time books are now assembled by the supervisors and approved by them, then sent to the roadmasters for review and approval, after which they are sent direct to the auditor's office, which office from them—the original record—prepares the pay rolls, labor and material distribution. This eliminates all clerical work on the part of the roadway department. The distribution of laborers' time is made directly by the foreman, in accordance with the requirements of the Interstate Commerce Commission. Detailed information is given in the book, so that the foreman will know under which heading to put his distribution.

The Nashville Chattanooga & St. Louis has a system somewhat similar to that of the Southern, as far as the track foreman is concerned. The distribution is made very carefully, and furnishes data from which accurate costs of all classes of work are figured up each month. The reports are made simple, so that they may be easily understood. The cost data is worked up from them for each division each month by the general roadmaster, and copies sent to the various

divisions, so that comparisons may be made. Simplicity, accuracy and sufficient detail for all purposes are the chief advantages of the system, is the claim of the officials of this road. The time book and distribution sheets are in one book, so arranged as to cover the entire month's work. The foreman enters time and distribution daily, while the work is fresh in his memory, but is relieved of the necessity of mailing it to headquarters daily. No extra report is required from which to make the distribution at the office.

Semi-Monthly Time and Monthly Distribution—Reports of the time of laborers on the Chicago Great Western are required only semi-monthly, with the exception of overtime reports, which are required daily. The officials state that the advantages of the forms which are being used are that the necessary information can be obtained direct from them, with which to compile reports for the Interstate Commerce Commission. The Pennsylvania Lines West follow a method similar to that of the Chicago Great Western, the time reports being required semi-monthly, and daily in only a few cases. Only one material blank is required, and that weekly. Tool reports are required once in three months. The supervisor's clerk helps such foremen as need assistance in making up the reports, and on heavy construction work several clerks are sometimes employed.

The time book on the Erie Railroad is drawn up in such form that a man of little education should be able to grasp the idea of reporting time. On the last two pages of the book, careful instructions are given to the foremen on how to make out the time book, and these are supplemented with verbal instructions. But

Form 202 C. S.

DISTRIBUTION OF TRACK LABOR

_____ Division _____ District or Branch. Name of Gang _____ Number _____

11-14-70,000—S

DISTRIBUTION OF LABOR PERFORMED DURING MONTH OF _____ 191

DESCRIPTION OF WORK	1	2	30	31	TOTAL DAYS WORKED	Not to be filled in by Foreman: TOTAL AMOUNT		Chargeable to Acct. No.
ORDINARY ROADWAY REPAIRS—Blasting rocks; ditching and cleaning ditches; placing and cleaning drain pipes (not under tracks); crowning track ties with retaining earth; filling borrow and cattle pits; landscape gardening (except at stations); oiling roadbed; restoring roadbeds, cuts, fills and embankments to standard width; sloping cuts; plowing and digging fire guards; dressing ballast; loading and handling miscellaneous scrap, drift, cinders, dirt and other material (except ties, rails and other track material) from right of way, and from road and terminal tracks (including tracks at stations, engine yards and car yards); cleaning streets used as right of way; extinguishing fires on right of way and adjacent thereto; walking, watching and patrolling tracks and right of way; repairing retaining walls, riprap, piling, piers, breakwaters and revetments; diverting channels of streams to prevent cutting, washing and sliding of embankment.								202-1
EXTRAORDINARY ROADWAY REPAIRS—Removing slides, dangerous rocks and other obstructions; repairing and keeping roadbed clear on account of freshets and washouts; building and removing temporary tracks around slides and washouts; protecting roadbed and tracks from water; watchmen on account of bad spots in roadbed and tracks.								202-2
REMOVING GRASS AND WEEDS—Mowing right of way, removing and burning brush, grass and weeds.								202-3
TUNNELS AND SUBWAYS—Repairing, ventilating, lighting and watching tunnels and subways for the passage of trains.								206
BRIDGES (framed, plate girder, arched or pile structure of wood, metal or masonry, having a span or spans more than 16 feet each in length)—Cleaning channels under, etc.								208-1
TRESTLES (structures formed of two or more short, simple girders having spans of 16 feet each in length or less, resting upon upright bents). **CULVERTS** (covered drain or waterway under the embankment, having a clear opening of 16 feet or less; also a structure formed of a single, short, simple girder, having a span of 16 feet or less in length, resting upon abutments—includes one span pile structures with span of 16 feet or less)—Cleaning of, etc.								208-2
BALLAST—Loading or unloading for use in repairs of track.								218
APPLYING BALLAST—ORDINARY—Preparing roadbed and applying ballast for repairs of tracks.								220-1
APPLYING TIES AND TIE PLATES—ORDINARY—Unloading and distributing and applying ties and tie plates for repairs of tracks; gathering up and disposing of ties released; respacing ties.								220-1
APPLYING RAILS AND OTHER TRACK MATERIAL—ORDINARY—Unloading, distributing and laying rails and applying other track material for repairs of tracks; gathering up and loading material released; (except for temporary tracks around slides, washouts, wrecks, etc.); adjusting for expansion and contraction of rails.								220-1
ORDINARY TRACK REPAIRS—Aligning, surfacing, gauging and shimming tracks; tightening track bolts and track spikes; taking up and relocating tracks; repairing and replacing rail rests.								220-1

Fig. 12 Southern Pacific Time Report, Showing Detailed Description of Work in accordance with

EXTRAORDINARY TRACK REPAIRS—Restoring rails, ties and ballast in case of washouts, derailments and wrecks.								220-2
RIGHT OF WAY FENCES—Repairs of. Includes farm gates, cattle guards, wing fences, aprons and hedges, permanent snow and sand fences erected in lieu of ordinary right of way fences, excludes those around fuel stations, station and shop grounds and building sites.								221
SNOW AND SAND FENCES AND SNOW SHEDS—Repairs of.								223
CROSSINGS AND SIGNS—Repairs of, (except Railway crossings at grade).								225
TELEGRAPH AND TELEPHONE LINES—Repairs of.								247
BUILDINGS, FIXTURES AND GROUNDS—Repairs of, including fences, sidewalks, driveways and streets on or adjacent to premises. State kind of building.....								
REMOVING SNOW, ICE AND SAND—Cleaning snow, sand and ice from tracks and yards, and handling and setting up portable snow fences.								272
***STATION EMPLOYES**—Cleaning up around stations, removing snow and ice from station platforms, walks and stock yards, and attending switch lamps outside of switching yards.								373-2
STATION SUPPLIES AND EXPENSES—Handling station coal.								376
***YARD SWITCH AND SIGNAL TENDERS**—Attending switch lamps inside of switching yards.								379
WATER FOR YARD LOCOMOTIVES— Handling pumphouse coal at.....Station. **WATER FOR TRAIN LOCOMOTIVES**— Handling pumphouse coal at.....Station.								385
TRAIN SUPPLIES AND EXPENSES—Cleaning, sanding and bedding stock and other cars.								397
CLEARING WRECKS—Building or removing temporary tracks around wrecks (excludes repairing roadbed and track account of wrecks), reloading of transferring freight, etc.; watchmen; state whether freight, passenger or work train.								402-1
DAMAGE TO LIVE STOCK ON RIGHT OF WAY—Burying stock (state whether killed by freight, passenger or work train).								415
NEW WORK, WORK ORDER NUMBER..... Detail time by classes of work—Grading, Laying and Surfacing, Ballasting, etc.								417
TOTAL DAYS WORKED, EACH DAY								

CORRECT: _____ Foreman. APPROVED:

_____ Roadmaster.

TO FOREMEN:

The distribution of labor performed must be entered and footed at the close of each day.

The "Total days worked, each day," must agree with the Time Roll.

EXAMPLE—If there are 1 Foreman and 5 Laborers on a section on the 4th day of the month, there should be 6 days shown as "Total days worked, each day," in the column headed "4" both on this Report and on the Time Roll.

All labor account of Work Orders must always be shown opposite "New Work, Work Order No.....," and not opposite the other heads. Order number must be shown in all such cases.

*Switching Yards refer only to Points where regular switching service is maintained.

Included Under General Headings, such as applying ballast; made up I. C. C. rules.

one material report, monthly, is required and tool reports are only required when specially called for by the division engineers, or when the annual inventory is made. The forms have been changed and greatly simplified in recent years, partially on account of the advent of the foreigner as track foreman, and to make a better accounting than was possible in the past.

The time and distribution of labor on the Wabash Railroad is made up on a single large sheet, the total time above, and the distribution below. The distribution is made on the basis of total number of hours put in on each kind of work, rather than by the hours of individual laborers. A daily report of a very simple nature is made to the supervisor, and, this, together with a single sheet, including a report on all the material and tools on the section, is all that the foremen are required to handle. The material and tool report is required at the end of each month.

Semi-Monthly Reports of Both Time and Distribution—On the Minneapolis St. Paul & Sault Ste. Marie, the time roll, showing both total time worked and distribution of labor, is sent to the division superintendent twice a month by the roadmaster. This makes it unnecessary for the foreman to carry the distribution over for a whole month, after he has made a report on the time for a half month, and thereby simplifies his work. A daily report of time worked is sent to the roadmaster by each foreman.

Weekly Time and Monthly Distribution—On the Chicago Rock Island & Pacific a weekly report of the hours worked is required, and a semi-monthly report is required for use in making up the pay roll.

The material books are made up to indicate all needed information. At least 90 per cent of the sections have but one material report, and the report on creosoted switch ties, besides their time report. A requisition form is made out each month for material and supplies needed for the following month. This road recently changed its methods somewhat on account of the necessity for paying semi-monthly. A detachable time sheet was added to the time book to cover the first 15 days of the month. This is detached and sent in on the fifteenth, after the time has been entered, and the total is carried to the last half-sheet, so that the foreman is able to obtain a grand total for the month.

The Chicago & Alton requires weekly reports of both time and distribution of laborers, semi-monthly reports of time for use in making up the pay roll, and a complete distribution of labor, monthly. This gives the supervisor the total labor expenditure at the end of each week, and gives him a chance to make up comparative statements in connection with the allowance and expense of the previous year. No tool report is required, but a blue print giving a standard list of tools is posted in each toolhouse. Supply cars replace and take up tools, in accordance with this list. All material is charged directly from requisitions, with the exception of rail and ties, which does away with the necessity of the foreman making up reports for material other than rail and ties.

Daily Time and Monthly Distribution Reports—On the Missouri Kansas & Texas a daily time report and a monthly report on distribution is required. The daily report is used for keeping track of expenditures, and for obtaining the unit costs of various classes of

work. This road but recently changed from the monthly to the daily system of time reports.

The Norfolk & Western has a similar method. The daily reports of labor expended are checked against the monthly distribution. The time of each laborer is required to be entered daily in the time book. The daily reports enable officials to check up the expenditure on any authority work, at any time.

On the Southern Pacific a daily report is kept in the monthly time book, but the information is forwarded each night on a form to the roadmaster. The distribution of track labor is likewise made daily, but is not sent to the roadmaster until the end of the month. The distribution, however, is reported to the roadmaster four times a month. The monthly distribution of track labor is made up to conform with the Interstate Commerce Commission ruling, whereas the weekly report of distribution is made up for the information of railway officials only. Italians, Greeks, Mexicans and Japanese foremen are employed, but no particular trouble is experienced with them in the handling of these reports, which have been simplified and yet require sufficient information for the auditing department, as well as for the Interstate Commerce Commission. (See Fig. 12, Southern Pacific Report Blank, page 152.)

Semi-Monthly Time Reports and Weekly Distribution Reports—On the Atchison Topeka & Santa Fe Coast Lines, the time report is required at the middle and the last of the month, and distribution of labor is required once a week. The chief advantages for this method are said to be that it relieves the foreman of the clerical work of making up daily reports, and

makes it unnecessary to stop trains daily at isolated places to forward the mail.

Many of the section headquarters are at points where trains do not stop, except on flag, and some are located at points where trains do not stop at all. The explanation as to just what information is wanted on material and tool reports is printed in plain language, such as can be easily understood by a foreman of ordinary intelligence. Further, the sheets are bound into the time book, so that they do not have to be handled separately. The time book has recently been revised, and some of the forms simplified, partly to reduce the clerical work of the foreman and partly to make it easier for the clerical force to segregate charges to the proper accounts.

Weekly Time and Daily Distribution Report—On the Boston & Albany, reports on time of laborers are required weekly, and distribution of labor reports are required daily. By the daily report system the officials consider they are getting fresh information, and that nothing is likely to be forgotten. This also enables the supervisors to keep in closer touch with the progress of each foreman's work, which is a great advantage. Correct unit costs of a day's work are obtained on the day following. The time is distributed daily, and the daily reports are checked against the weekly time report, to detect any error on the foreman's part.

Daily Time and Distribution Reports—Most foremen have little education along clerical lines, and on the Baltimore & Ohio they seemed to be unable to prepare the monthly time book accurately. The fore-

men had difficulty in balancing the time for the month, and in making the distribution of labor agree with the total hours' work. There were also frequent errors in marking up the men's time, probably because the foremen did not enter the time each day; the monthly system was, therefore, considered inaccurate and unsatisfactory. Under the present system of reporting time daily, the foreman is compelled to enter the time of every man in the time book at the end of each working day, after which he makes out his daily report of time and distribution of labor, and mails both reports to the division engineer on the first train. It is much easier for the foreman to make up the full reports daily while the whole thing is fresh in his mind, insuring more accurate timekeeping for the men and more reliable distribution of labor. A carbon copy of these reports is sent to the supervisor. The increasing number of foreign track foremen is no doubt responsible for the unsatisfactory reports obtained under the old system.

The material reports have likewise been simplified, and are now required daily, thus relieving the foremen of a large amount of clerical work at the end of the month. Most of the foremen could not make the old material report up complete, and it was necessary for the supervisor to spend a lot of time straightening the reports out. The simple daily reports of the amount of material used, shipped and received each day are giving greater accuracy. The present system has been in use since 1910, with a few slight changes, and is giving satisfaction.

The Cincinnati, Hamilton & Dayton Railway is

THE DELAWARE AND HUDSON COMPANY

BUREAU OF DEPARTMENTAL ACCOUNTS

_____ DIVISION

DAILY REPORT OF LABOR PERFORMED AND MATERIAL USED BY TRACK FORCES, _____ GANG NO. _____

LOCATED AT _____ FOR THE _____ DAY OF _____ 191____

TIME WORKED DURING THE DAY

	NAME (GIVE FULL NAME AND MIDDLE INITIAL)	BRASS CHECK NUMBER	OCCUPATION	HOURS WORKED	RATE
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29	TOTAL HOURS WORKED BY GANG				

	KIND OF WORK DONE DURING DAY (SHOW EACH KIND OF WORK ON A SEPARATE LINE, AND GIVE NUMBER OF HOURS WORKED IN COLUMN "HOURS")	HOURS: MAIN TRACK	HOURS: SIDE TRACK	HOURS: JOB ORDERS	If Job Order Give Number
30					
31					
32					
33					
34					
35					
36					
37					
38					
39					
40					
41					
42	TOTAL HOURS WORKED BY GANG				

NOTE: IF TRAIN OR ENGINE SERVICE, OR SPECIAL EQUIPMENT, SUCH AS WRECKER, STEAM SHOVEL, PLOWS, TOOL CARS, ETC., USED IN CONNECTION WITH WORK, A REPORT SHALL BE MADE BY THE FOREMAN ON FORM 2941, DAILY WORK TRAIN REPORT, TO COVER SAME.

CHECKED AND FOUND CORRECT:

_____ CLE. _____ FOREMAN.

FOREMAN SHALL USE OTHER SIDE TO REPORT MATERIAL.

Fig. 13—Delaware & Hudson Time and Distribution Report.

using practically the same system and the same forms as the Baltimore & Ohio.

The Delaware & Hudson Company changed its methods of reporting maintenance of way work February 1, 1916, and now requires daily reports on time, distribution of labor and materials. All the blank forms are made up on one sheet, the time and distribution on one side, material and tools on the other. The foreman writes-in the names and hours worked by the men, the kind of work, and number of hours spent on each kind of work during the day. The hours are entered up under three headings: (1) Main-track. (2) Side-track. (3) Job orders. See Fig. 13 on page 159. On the opposite side of the sheet is given the daily material report, the top part having a place for material used, the middle for material taken from side-tracks, and the lower for material received or shipped away. The different materials are written-in by the foremen.

The Cleveland Cincinnati Chicago & St. Louis follows practically the same method as the Baltimore & Ohio. The daily reports show the nature of the work performed, the exact location and length of time consumed. From these reports the labor distribution is made daily in the office of the engineer maintenance of way. On extra gangs, especially those applying rail, spacing ties, surfacing, dressing, etc., a daily report is required, showing the work accomplished and its cost, this being used for accounting purposes and for gathering cost data. Few foreigners are employed as foremen, but the reports have been simplified as far as possible, in order not to impose too much of a burden upon the foreman. The supervisors are relieved

DAILY MATERIAL REPORT

FORM 2893, C.

SECTION NO._____ DATE_____ 191__

	MATERIAL USED ITEMS OF MATERIAL	UNIT	KIND: STATE IF NEW RELAY S. AND V. OR SCRAP	AMOUNT USED AND WHERE USED: MAIN TRACK REPAIRS AMOUNT USED	SIDE TRACK REPAIRS AMOUNT USED	FOR NEW WORK, TEMPORARY TRACKS, JOINT TRACKS, OUTSIDE COMPANIES, PERSONS, ETC. AMOUNT USED	JOB ORDER NUMBER	SHOW NAME OF TRACK OR PERSON
43								
44								
45								
46								
47								
48								
49								
50								
51								
52								
53								
54								
55								
56								

	MATERIAL TAKEN FROM TRACK ITEMS OF MATERIAL	UNIT	KIND: STATE IF NEW RELAY S. AND V. OR SCRAP	AMOUNT TAKEN FROM TRACK AND WHERE FROM: TAKEN FROM MAIN TRACK AMOUNT	TAKEN FROM SIDE TRACK AMOUNT	FROM NEW WORK, TEMPORARY TRACKS, JOINT TRACKS, OUTSIDE COMPANIES, PERSONS, ETC. AMOUNT	JOB ORDER NUMBER	SHOW NAME OF TRACK OR PERSON
57								
58								
59								
60								
61								
62								
63								
64								

MATERIAL RECEIVED OR SHIPPED AWAY

	ITEMS OF MATERIAL	UNIT	RECEIVED: AMOUNT	NEW RELAY OR S. AND V.	WHERE FROM	SHIPPED AWAY: AMOUNT	NEW RELAY OR S. AND V.	WHERE TO
65								
66								
67								
68								
69								
70								
71								
72								
73								
74								

FOREMAN MAY USE THE SPACE BELOW TO REPORT CARS RECEIVED AND SHIPPED, HURRY MATERIAL, ETC. ALSO TO REPORT MATTERS OF INTEREST TO SUPERVISOR, ETC.

75	
76	
77	
78	
79	
80	

APPROVED FOR LABOR AND MATERIAL: _____ SUPERVISOR

THE ABOVE REPORT IS CORRECT: _____ FOREMAN

Fig. 14—Daily Material Report, Delaware & Hudson.

of as much clerical work as possible, and all the clerks on each division are concentrated in the office of the engineer maintenance of way. The timekeepers in his office are able to make the distribution of labor daily, from the reports which are received from foremen. A ledger account is kept of each section or gang, and the amount of material they have on hand can be determined at any time. Under the old method of handling time and material, clerks were employed at the more important stations, such as Cleveland and Indianapolis, to take care of the time for all the gangs at those places. Under the present system this is not found necessary.

The New York Central Railroad has been using daily reports of time and distribution, and finds that more accurate reports are obtained and that there is less likelihood of the pay rolls being padded. The reports have given very good satisfaction on this road. Material and tools are reported once each month on simple blanks. The Pittsburgh & Lake Erie has a similar system.

On the Pennsylvania Railroad daily reports are required on both time and distribution, and at present, monthly reports on materials. The advantages of the system, as worked out on this road, are that the supervisor knows at the close of each day just the amount of time and labor expended on his section, and is in a position to check the number of men, and to see how his labor charges compare with his allotment for labor. This road has recently changed from a monthly to a daily time report, and has in view changing from a monthly to a daily material report, if it can be done without increased clerical labor and cost.

Conclusion—It is the writer's opinion that the daily report of both time and distribution is a particularly valuable method under existing conditions. The track foreman is certainly entitled to all the consideration which can be shown him, and his hours are long enough, without requiring him to use his evenings in clerical work. It is realized, however, that many of the systems now in use—where reports are required weekly, semi-monthly and monthly—have been so simplified that they are almost as easy to handle as the daily reports.

CHAPTER VIII.

SPRING WORK.

A track is no stronger than its weakest point. It is better to have uniformly fair track than to have stretches of excellent track mixed in with stretches of poor track.

After the winter months the roadway will usually require immediate and vigorous attention. The frost will leave the ground faster where the sun gets a chance to shine directly on it, and the irregular manner in which the frost goes out causes the track to settle unevenly, and shimmed track must be watched closely to avoid accidents. On curves, settlement may affect the elevation enough to cause derailments. The places in the track where shims have been used should be marked, with the idea of remedying inefficient drainage—the usual cause of heaving.

The success of maintenance of way work, particularly under present labor conditions and with the small forces allowed, depends primarily on the proper planning of the work. Every effort should be made to prevent delays caused by lack of materials or tools.

Many roads are standardizing section gang work, specifying certain days or periods for doing certain kinds of work, the track gangs all being held up to this program. However, if a foreman completes a job before the allotted time he is free to go on with other work; and if he does not finish he continues at it past the days allotted, and makes the necessary explanation to the supervisor or roadmaster. There are some ob-

jections to this system, for it may sometimes prevent the track gangs from taking advantage of favorable conditions for doing work of a different kind than that allotted. On the roads where this system has been put into force, however, the advantages are such that they continue to follow it in spite of its drawbacks.

The spring months are the best in the year for doing track work. The days are cool, and labor is better and more plentiful than in the summer or fall. This is illustrated by some authentic costs which were published by the author in "Practical Track Work," from which we quote: "The total cost chargeable to raising a piece of track during the early spring was $5064 for raising 60,100 ft. of track, an average raise of 6 in. This amounts to about $445 per mile and includes lining and dressing up the track to standard. During the summer a total of 74,400 ft. of track was given an average raise of 6 in., the total cost being $7850, which amounts to about $560 per mile. The conditions were practically identical in each case. The work done in the spring was 20 per cent cheaper than that done in the summer. The work was done by a contractor with a very efficient supervising force."

Routine Track Work—Following is a list of the kinds of spring work which are necessary in localities where the ground freezes in the winter time:

While frost is still in ground the supervisor should:

(1) Check up section tools for the summers' work.

(2) Choose and examine the foremen for extra gangs.

(3) Order the tools, boarding camp cars and other supplies for extra gangs.

(4) Have work trains distribute ties (if not done previously).

(5) Have work trains distribute rails (if not done previously).

The track foreman should:

(6) Keep switches free from water or ice.

(7) Remove snow and ice from waterways.

(8) Inspect and gauge switches and switch leads.

(9) Inspect and renew guard rails and frogs.

(10) Replace bad rails.

While frost is going out of ground:

(11) Watch shimmed places and reduce sizes of shims as track settles; put in shims in low places which develop.

(12) Clean up station grounds and track.

(13) Clean up freight, stock and yard tracks.

(14) Pick up scrap.

(15) Distribute track ties ready for renewals if this work was not done in the winter.

(16) Inspect anti-creepers and tighten any which have loosened during the winter.

(17) Scale off rock cuts, using the material for strengthening and building berm or for rip rap.

(18) Drive down all loose spikes and tighten loose bolts.

(19) Watch for soft spots, repair them and notify the operating department where slow orders are necessary.

(20) Run over the section quickly, taking out shims, swings in the line and the worst low places in the surface.

(21) Put in ties.

(22) Repair highway crossings.

(23) Patch up fences, especially those across water courses.

(24) Repair cattle guards.

(25) Straighten sign posts.

(26) Adjust expansion and tighten bolts on medium hot days, renewing them or the lock nuts when necessary.

(27) Take down portable snow fences.

(1) Checking Up Tools—The supervisor or roadmaster should make sure that each foreman is supplied with the proper equipment of tools to do his work most expeditiously. While it is the roadmaster's duty to see that tools are not scrapped too soon, he should also see to it that the ones retained are serviceable. Tools needing repairs should be shipped to the shops; this work should be done before the rush of spring work, to prevent delay.

(2) Extra Gang Foremen—The extra gang foremen should be chosen early enough to give time to break in relief foremen for the sections. If the relief foreman comes from another division, more time must be allowed him to become acquainted with the peculiar conditions on the section; if the man is to be promoted from among the laborers, he should be schooled by the regular section foreman for as long a time as possible before he takes complete charge.

(3) Extra Gang Supplies—Tools, boarding camp cars and extra gang supplies are likely to be missing after the gangs are ready to go to work—so these supplies should be followed up closely. The supervisor should continually keep after the proper parties so that plenty of these supplies will be on hand at the time the extra gangs are ready to start work.

(4 & 5) Distributing Ties and Rails—Some roads distribute ties and rails in the winter. If this has not been done, the distribution should be made in the early spring. If the ground is still frozen, the rails must be handled carefully so that they will not be broken. Varous devices may be used, such as skid rails, an A-frame if unloading out of stock cars, or a rail derrick. The latter is the most efficient where the rails are on flats or in gondolas, and especially where a rail derrick can be sent around to several divisions successively, it will prove to be a labor and cost saving appliance. If it is impossible to get the rail derrick at this time of the year, it is better to defer the distribution of rails from such cars until the derrick can be obtained.

(6) Keeping Switches Open—One of the most important duties of the track foreman in the spring is to keep the switches working. The water which accumulates during the day as the snow and ice melts will run into the snow holes and, freezing the rods and switch points, will prevent the switch from being operated. It is necessary, therefore, to give the switches attention every day, the best time being in the afternoon. In yards each man should be assigned a certain number of switches to look after and the foreman should inspect the entire number just before he leaves for the night.

(7) Cleaning Waterways—It is very essential that snow, ice and all rubbish be cleared out of waterways, surface or track ditches as soon as possible in the spring. Waterways which are dammed up are responsible for a good many embankments being washed out. Every precaution should be taken to prevent

water from flowing down onto the roadway, as far as possible, and to provide for quickly draining off water which does fall or flow onto the roadbed. Watchmen should be stationed at menacing points to promptly advise of dangerous conditions.

(8) Switches—During the winter it is impossible to make all permanent repairs to switches, switch leads, etc., and immediately after the snow and ice have melted, worn switch points should be renewed, switch points and switch leads re-gaged and the switches put in first class condition.

(9) Guard Rails and Frogs—Guard rails are frequently forced out of place in the winter time, and it is almost impossible to get at them to re-spike them properly in place. When the guard rails are re-set the track should be gaged, the guard rails being placed according to prescribed standards. Guard rails and frogs should be inspected and if worn out should be replaced.

(10) Replacing Rails—In the spring months the foreman can run over his section and replace track rails (including stock and lead rails) which are badly worn or which show signs of failure. This should be done after the snow and ice have melted away.

(11) Shimming—The frost going out unevenly will cause rough spots, which should be given immediate attention. It will be necessary to put in new shims at some places, while at other places the old shims will have to be removed and thinner ones gradually substituted till the track has settled back to its old bed.

(12 and 13) General Cleaning Up—All cinders, straw and other rubbish should be gathered up from

the track, either on the section or in yards, and this material should be used to patch up holes in the right of way or to strengthen weak spots in embankment shoulders. This not only gives more time for other work later, but allows the frost to go out of the roadbed quicker and the section gang to get started sooner at the work of smoothing up the track. Rubbish should be cleaned away from the rail base and insulated joints to prevent the failure of automatic signals.

(14) Scrap—Scrap will be covered up by snow and ice and will accumulate rapidly in the winter. It is usually necessary in the spring to make a special trip over the section to pick up all the scrap which has thus accumulated; this should be done as early as possible so as not to interfere with the important work which can be done only after the frost is out of the ground.

(15) Distributing Track Ties—As the danger of wash-outs is usually past by this time, it will be practicable to string out the track ties which are to be renewed, laying them at right angles to the track, each at its proper location. This work should not be left until the gang is renewing ties, as the time is then more valuable and should be used mainly for renewal work and not in distribution.

(16)—Rail Anchors—When snow and ice are on the ground it is impossible to do much in the way of inspecting or tightening rail anchors, but as the change in temperature is likely to start rails creeping, a thorough inspection of anti-creepers should now be made to insure that they are ready to efficiently resist any tendency to creep.

(17) Rock Cuts—Rock cuts should be scaled early

in the spring and all rocks which have been loosened by the frost should be rolled down and taken care of. This will prevent any of them getting onto the track and causing a derailment. Wherever soft clay cuts have slid or are sliding, these should be given attention at the same time, and the material obtained should be used for strengthening embankments. The rocks may be used at places where rip rap is needed. It may be possible to do some ditching now and to get the waterways cleaned out and in the best possible shape for thaws or heavy storms.

(18) Spikes and Bolts—It will be profitable for the foreman to go over his section and drive down the spikes snugly. This will help to prevent the rails from creeping and obviate the necessity of doing this work later, when putting in ties. If nuts are rusted to the bolts, a little black oil poured on bolts will greatly facilitate the work of tightening them.

(19) Soft Spots—Wherever soft spots develop in the roadbed, whether caused by water pockets, slides, or washouts, they should be watched minutely by the foreman and all necessary repairing done; but in every case the first thing to do in case there is a dangerous track condition, is to notify the operating department so that slow orders may be issued. In case some track is found which is impassable, the foreman should waste no time in getting out flagmen to protect it, and he should then report the matter to headquarters.

(20) Surfacing and Lining—After the frost is out, all shims should be removed and the track at these points surfaced and lined. While doing this, all bad swings in the track should be lined out and other very rough places should be smoothed up in order to make

the track ride fairly well and to make it absolutely safe.

(21) Putting In Ties—It is highly desirable to get started early at putting in ties, to push the work as hard as possible, and thus get this heavy work out of the way while the days are cool, at which time labor is more plentiful and more easily obtained. However, where the section is to be raised out of a face, it is better to wait and renew ties when surfacing. The subject of putting in ties was considered worthy of an extended treatment and was discussed in detail in chapter V.

(22) Highway Crossings—The planks of highway crossings are quite likely to be heaved up by the frost in the winter leaving open spaces under the planks for the accumulation of ballast and rubbish. Wherever this has occurred, the planks should be taken up, accumulated material cleaned out and the planks reset. Frayed ends of planks should be adzed down. Since the automobile has become so common it is especially necessary nowadays to keep crossings in first class condition. Crossing planks and cattle guards removed for the flanger may now be replaced.

(23 and 24) Patching Up Fence—Right of way fence and wing fences which have been broken down or damaged should be repaired. This applies especially to fences across water courses, etc. At the same time cattle guards should be carefully mended and repaired. Doing this work at this time will prevent stock from getting onto the track, and prevent damage claims.

(25) Sign Posts—All sign posts should be straightened up and placed in proper position so that they

may most easily be seen by those whom they are meant to warn. Particular attention should be given to crossing signs so that automobile drivers will be given the best possible warning.

(26) Expansion—The gang should go over the section the first real warm day to loosen the bolts in joints which have wide expansion and thus allow the rails to run up; after which the bolts should be again tightened to hold the expansion more evenly. If the angle bars stick after bolts are loosened, a smart blow with the spike maul will loosen them. Bolts should be tightened wherever they need it. Bolts should not be turned excessively tight, as when they are, all of the spring is taken out of the bolt and the nut-lock, and the bolt will stretch when subjected to the strains of passing trains. It is better to give track bolts attention oftener and not tighten them up so tight, than to spoil them by using long-handled wrenches. Bolts and nut-locks which are broken or are in bad order should be replaced.

Washouts, Slides and Water Pockets—The track should be inspected every day to prevent, if possible, washouts or slides. Ditches and waterways through embankments should be cleared out, and if necessary, in times of danger the foreman and his force should stay out all night to safeguard the track. It is often possible to prevent a bad washout if the foreman and his men are on the job to place bags of sand, rip rap, brush or other similar material in places where the embankment first starts to wash. In, or after a dangerous storm, the track should be inspected from end to end of the section just as soon as the men can get over it. The best man in the gang should be sent

over the short end of the section with instructions to flag trains if he finds any dangerous spots. The foreman should then take the other end of the section and run over it quickly to the opposite end to decide whether there are any spots which are dangerous for traffic; he should repair no track until he has ascertained whether it is safe for trains to use the track over his entire section. The foreman can then go back and repair places where a large gang could not work, leaving the larger holes for large gangs which may be sent. After inspecting the track, the foreman should promptly report the number of holes washed out and the amount of grade washed away, also the fence, bridges or culverts which have been broken down and will need repairs, sending the telegram to the roadmaster and also to the superintendent. A foreman or man who is inspecting the track should never stop to flag at the first hole or to repair it, as bad or worse holes may be found further down the line.

Conclusions—The work which can be best done in cool weather should be laid out for the spring months. Crowding the work at this time produces the following highly desirable results: First—it places the track forces in better shape for hot weather; second—a better class of men can be obtained; and third—the laborers can be held better than in summer, at which time farmers and people in other industries commence putting on men.

In the early spring the track force should go over the entire track, surfacing and lining only the worst spots and keeping the track in fair surface and then get started on the work of putting in ties. If this is done the work of tie renewals can probably be finished

by July or even June 1st, which gives the entire summer season to get the track in first class shape for the next winter.

It is highly desirable, in the spring especially, that the foremen distinguish between work which is *absolutely necessary* and that which it is desirable to do. For instance, the foreman when he starts out to surface the track will find a large number of low joints. If he stops to raise them all, the end of the section will be so rough that it will require a slow order long before he gets there. Only those places should be touched which are so bad that they are likely to cause comment from the operating people. Such places should be brought up to surface and line and the section covered in a hurry. The same thing might be said of all of the work done during the spring months. The foreman should always pick out that job which is the most necessary at the time and if he does this he will find that his work runs along much faster and that his track as a whole is in much better shape each succeeding week.

Much work has to be done over again because it is done at the wrong time; and in a great many cases doing a job at the wrong time will make it much harder to do the work which follows it. It is so essential that we think it will bear repeating to say—"do each day that work which is the most necessary, as viewed from present conditions and its effects on the future work to be done."

CHAPTER IX.

SUMMER WORK.

A track is no stronger than its weakest point. It is better to have uniformly fair track than to have stretches of excellent track mixed in with stretches of poor track.

As early as possible in the summer the section foreman should start at one end of his section, preferably the end furthest from the section house, and give the track a thorough going over, surfacing, lining, etc. While it is customary on some roads to renew ties in the summer, it will be found better if such work has been pushed through in the spring time, leaving the summer and fall for general repairs to track, to allow it to settle and be in first class shape long before the winter months. The advantage of starting at the far end of the section is that the foreman will ride over the section each day and thus can inspect the track and surface any exceptionally rough spots, or repair places which require immediate attention.

The full force should be kept even after the ties are renewed, so that the work of surfacing and general repairs to the section may make appreciable progress. With a gang of two or three men it is not possible to do much more than simply raise low joints, tighten bolts, etc.

The track should be given a raise out of a face every three years to prevent "waves" developing. If this system is followed, the tie renewals should be made mainly in the section surfaced out of face and

at the time of surfacing. The remaining two-thirds of the section should be disturbed no more than absolutely necessary.

The summer work might be lined up somewhat as follows:

1. Run over the entire section quickly, say in a week or ten days, and surface and line the places which are roughest. (One roadmaster has applied the term "skirmishing" to this work, which is very expressive of just what should be done.)

2. Finish renewing track ties if this work is not completed, and renew switch ties.

3. Dig fire guards along right of way or mow fireguard swaths in the neighboring fields.

4. Clean up station grounds and right of way.

5. Start the general surfacing and cleaning up at one end of the section (unless general ballasting or relaying is to be done)—this work to include—

A—Bringing up and leveling all low joints and low spots.

B—Taking kinks out of gage side of track.

C—Full tamping, filling in centers, and dressing track out of a face.

D—Cleaning shoulder of weeds and trimming grass line.

E—Strengthening weak points in embankments.

F—Replacing joint ties where rail has run and straightening up ties not square across the track.

G—Doing any other small jobs, such as driving down spikes, tightening bolts, etc., in order to leave each section of track in first class shape.

6. Mow right of way. (It will probably be necessary to interrupt the work of general surfacing to do this work; some state laws require the right of way to be mowed at certain times.)

7. Cut track weeds.

8. Burn over right of way as soon as dry.

9. Make permanent repairs to interlocking and switches.

10. Inspect and repair grade crossings.

11. Inspect and repair highway crossings.

12. Inspect and repair fences.

1. Skirmishing—The foreman should always keep close watch of his entire section and immediately raise any spots which become rough enough to be especially noticeable on trains, but leaving the regular work of summer surfacing no oftener than absolutely necessary. The foreman should use his best judgment, and never allow his inclination to put the adjacent track in first class shape to cause him to spend too much time in such work.

The foreman should go over his track occasionally with the express purpose of taking care of rough spots or places in need of immediate repair. A good foreman will run over his section in a week, or at most ten days, three or four times a year, or oftener, to pick up such spots. The level should always be used in raising the low places.

2. Renewing Switch Ties—Switch ties are somewhat harder to handle than track ties; and therefore switch tie renewals should be made when the gang is at its maximum size. It is also usually necessary to do more digging to remove switch ties because they are longer than track ties, and adjacent tracks inter-

fere when pulling them out. It will frequently be found economical to jack up the track a little, in order to get the ties out without doing an excessive amount of digging, a method being adopted which will prevent ballast from running under any spiked ties and spoiling the surface of the track.

Methods of Renewing Switch Ties—Switch ties may be renewed (1) the same as track ties, putting in one or two at a time; (2) the ballast may be stripped out, the track flagged, the spikes removed, rails jacked up and all of the rotten ties taken out at once and replaced; (3) the ballast may be stripped out, spikes taken out of eight or ten rotten ties and these renewed, after which another section of the switch may be handled in the same manner; (4) the ballast may be stripped out of the entire switch, the flags sent out, the spikes removed from half the ties, switch ties put in and enough spiked to hold the track, after which the rest of the old ties may be removed, the switch ties spaced correctly and spiked. (For more detailed description of the several methods of putting in switch ties, see "Practical Track Work," page 105.)

3.—Digging Fire Guards—Many times the foremen neglect to dig fire guards and in a dry summer this is quite likely to lead to extensive fire losses—sometimes amounting to much more than the entire expense of the section gang for the summer months. As the prevention of fire is very essential, roadmasters and supervisors should insist that fire guards and all other possible protection be given first attention as soon as the grass begins to get dry. This is one of the most important jobs for the early summer. A swath 30 ft. wide may be mowed in the fields 150 to 200 ft. back

of the right of way fence, or if farmers will not allow this, the foreman should have a double furrow plowed close to the fence. Engine sparks will frequently carry beyond the right of way, hence the advisability of going beyond the fence line for fire protection.

4. General Cleaning Up—Since the public is greatly impressed by the appearance of the roadway, it is usually advisable to give the station grounds and right of way a general cleaning up before starting in on general surfacing. If necessary a certain number of days of each month should be set aside to keep the station grounds and right of way clean. It is a fact that the appearance of a roadbed has a lot to do with the impression which passengers, or even many officials gain of the road. A track which is well dressed off and looks clean, even if it is a little rough, will many times impress passengers as smooth riding track.

5. General Surfacing.—Most of the time in summer should be given over to a general overhauling, surfacing and leveling of the section; and while it will be necessary to interrupt this work for weeding, mowing and burning the right of way, etc., the foreman should always keep in mind that the main work is to start at one end of the section and work progressively toward the other end, leaving a finished piece of track behind each day. Wet weather may also interrupt this work, although with good gravel or stone on a good sub-grade, surfacing may be done as well after a storm as any other kind of work with the possible exception of tightening bolts or driving down spikes. The level should be used constantly; it should be tested each morning by laying on a piece of track and noting the position of the bubble, then turning the

level end for end and noting whether the bubble takes the same position. An imperfect level should not be used; where a good level is temporarily unobtainable a wooden shim should be made and nailed to one side of the level, its thickness being made so that it corrects the error.

The sags should be taken out of the high side of tangent track, and the low side brought up with the level. On curves the low side should usually be surfaced and the high side raised with the level. When there is too much elevation, however, this process will have to be reversed.

During threatening weather it is a good idea to work near the section house where the men may obtain shelter. It is sometimes possible to do the station-grounds' cleaning entirely on such days. The surfacing at the station should be done on threatening days when it is advisable to keep the men close to shelter.

It is good practice to raise the track out of a face once every three years, the best way to do this being to raise a third of the section each year. Unless this is done the track will get wavy, although the joints can be kept surfaced up so that it will ride smoothly. If this system is followed, the tie renewals should be made in the third of the track surfaced to a face, at the same time the raising is done. Spikes should always be tapped down tight ahead of the surfacing gang, so that the ties will come up snug with the rail when the track is raised.

(A) Lining—When going over the section giving it a general surfacing, the foreman should stop raising early enough in the afternoons to fully tamp, line, fill

and dress up the track. The lining should always be done before the track is dressed up. The foreman should stand straddling the rail with his back to the sun when lining. Long swings can be lined out if the foreman will stay an eighth or quarter of a mile from the liners. Short kinks can best be lined out by getting up 150 to 200 ft. from the liners.

(B) Gauging—As soon as the foreman has taken the kinks out of the line side he should delegate a couple of men to take all the kinks out of the gauge side. Sometimes, where track is badly out of gauge, it is necessary to have the track gauged before it can be lined up correctly. When trouble is experienced in getting a short kink lined out, the track should be tested and then gauged, if necessary, after which the lining may be completed. If the foreman will keep gauging constantly in mind as he goes over the track, it will enable him to maintain better line as well as give a better riding track.

(C) Dressing Up—The track should be carefully filled in and dressed out of a face as the work progresses, except possibly in stone ballast. The ballast should be shouldered off and lined to standard and everything completed. It is bad practice to leave gravel or inferior ballasted track without filling in and dressing it, particularly in a wet climate, as in a heavy storm the water will collect in the holes left and will let the track down, necessitating resurfacing; water will sometimes accumulate enough to cause churning.

(D) Weeding—It is economical practice not to weed off the shoulder till the surfacing is being done, at which time many weeds will be uprooted or

tramped down in the process. The shoulder should then be thoroughly weeded, thus giving the newly surfaced track the finished appearance which is so desirable.

(E) Strengthening Embankment—Unless embankments are strengthened, the work of surfacing may be partially wasted, for a weak point in the embankment will allow the gravel to run away and let the track down again. For this reason, weak spots in the bank should be strengthened when or immediately after surfacing by throwing up dirt from the foot of the embankment, or possibly by hauling some dirt from a place where the bank is too wide. When the section forces are too small, extra gangs should be put on to strengthen weak embankments.

(F) Respacing Joint Ties—In order to make a complete job of the surfacing, the ties should be respaced wherever the spacing is bad. If joint and shoulder ties are not properly spaced, they will not give the necessary support to the newly surfaced track and will let the joints get low again. Where rails are anchored by slot spiking at joints, rail creeping will cause the joint ties to be shoved off of their beds, leaving a wide space on one side of the joint and a very narrow space on the other, bulging up the ballast ahead of the joint and leaving scant ballast back of the joint. Such conditions should be corrected.

6. Mowing Right of Way—Wherever possible the weeds on the right of way should be cut by mowing machines, as it takes the section gang off of its regular work too long to have it done by hand. It is often possible to hire farmers to mow the weeds and sometimes old ties or timbers may be given in

part payment for the work. It is a good deal cheaper to do the work by machine than by hand. One mowing machine will do as much work as a whole gang of men, and frequently more.

There are, however, some rough sections where mowing machines cannot be used at all, and even when they are used there may be a good deal of trimming to be done with scythes. A grindstone should be provided for the gang to keep the scythes sharp, as a man will do at least twice as much work with a sharp tool.

7. Cutting Track Weeds—In some ballast, the track weeds will become so noticeable that they will cause comment by higher officials long before the foreman can get over his section with the surfacing. In this case the work will have to be interrupted and the gang started over the section to do weeding. Ordinary No. 2 shovels should not be used for this work, as they are not only harder for the laborers to use, but cut down the amount of work accomplished. A long handled scuffle hoe is not only much easier to use, but with it a man can accomplish about twice as much work as with an ordinary shovel. The tools should be ground often enough to keep them sharp; time spent in sharpening the tools will be more than repaid by the increased amount of work the laborers do.

Chemicals and Weed Burners—Several machines for burning track weeds are on the market, as well as appliances for spraying the ballast with a chemical which will kill weeds. Either of these methods are a help to the trackman and especially so on those lines where the foreman cannot find the time to devote to

weeding which is necessary if his track is to be kept clean. The relative economy of burning as compared with chemically killing the weeds has yet to be demonstrated.

8. Burning the Right of Way—As soon as the weeds which have been mowed are dry enough, the right of way should be burned over in order to prevent fires starting and spreading to adjoining property. If possible a day should be picked out when there is not much breeze, so that the fire can be easily kept under the control of the section forces. Fires should be started at the fence line and burned toward the track, if possible, as in this way the gang can cover much greater territory, it being simply necessary to start the fire and after a fairly wide swath has been burned, put out the fire at the fence line, the rest of the right of way burning over up to the track without much further attention.

9. Interlocking and Switch Repairs—It is necessary to give the interlocking attachments and switches a thorough inspection during the summer in order to renew any parts which were missed in the spring, or which may have become defective since that time.

10. Railway Grade Crossings—Railway grade crossings require frequent surfacing, especially those crossings which are at right angles or nearly so. Special attention should be given to them after heavy rains, and new crossing frogs should be ordered in plenty of time so that they will be received for renewal before the old crossings become dangerous. Summer is the best time to renew crossings provided the section gang is maintained at its full strength. It

may be necessary to double up several section gangs in order to handle a renewal, in which case the work should be done at a time when it will conflict least with the general progress of maintenance work.

11. Highway Crossings—Highway grade crossings will require some attention during this period, especially if there have been heavy rains and ruts have developed at the crossings or in the approaches. Public opinion is unfavorably impressed by the way in which some grade crossings are maintained, and the prevention of accidents caused by automobiles or motor trucks stalling on the crossings, is a strong argument for their proper maintenance. The long wheel bases of touring cars require that the approach to a crossing be well rounded off so that there will be no danger of the body of the automobile hitting the crossing and stalling when the front and back wheels are on the approaches.

12. Fences—Fences should be inspected and repairs constantly made so that stock will be prevented from getting onto the right of way or onto the track. The foreman should watch the gates opening onto the right of way on every trip he makes over the section, closing any which are left open. The farmers should be asked to keep the gates closed and if they are treated diplomatically, their co-operation may be obtained.

Conclusions—While the general surfacing of the section should be the principal summer work, the foreman should not fail to take care of other features which require his urgent attention, such as weeding, repairing rough places, making fire guards, and doing emergency work.

CHAPTER XI.

FALL WORK.

A track is no stronger than its weakest point. It is better to have uniformly fair track than to have stretches of excellent track mixed in with stretches of poor track.

The foreman should bear in mind all through the fall that it will be impossible to do much work on the track during the winter, particularly on northern roads, and every hour should be used for the work which is most important. The following program of work is suggested:

1. Finish surfacing if not completed.
2. Run over the entire section surfacing and lining any low places which have developed since the summer work.
3. Cut and burn over weeds on the right of way; clean up station grounds.
4. Repair road crossings and holes in driveways or highways and approaches.
5. Set up flanger signs.
6. Clean surface and track ditches and if possible place the material where it will strengthen embankments.
7. Drain water pockets or soft spots in the roadbed.
8. Clean drain pipes, culverts, cross ditches and other waterways.
9. Adjust the expansion on warm days, renewing bolts and angle bars and tightening bolts.

10. Re-gage track where necessary and tap down all loose spikes snugly to the rail.

11. Repair switches, frogs and guard rails, renewing or respiking plates and braces where necessary.

12. Dig snow holes for switches, guard rails, movable point and spring rail frogs and also around movable interlocking appliances; clean ballast away from rail bases to prevent short-circuiting the signal circuits.

13. Repair side tracks and make necessary renewals.

14. Run over the section, giving the low places the last touching up just before the frost gets into the ground.

15. Make estimates of new ties, crossing planks, etc.

AFTER THE GROUND FREEZES.

16. Set up portable snow fences.

17. Check up winter tools and supplies.

18. Inspect and tighten anti-creepers.

19. Put repair rails and angle bars on rail seats.

20. Repair fences.

21. Place angle bars, braces, tie plates, joint plates, etc., on platform of ties to prevent being covered with snow.

22. Place rip rap around abutments, piers and embankments which are subject to ice gorges.

(1) Surfacing—The general surfacing of the section should have been finished in the summer, but if not completed, it should have preference over all other work in the fall.

(2) Low Places in Track—Low places which have

developed since the summer's work on any part of the section should be picked up. It is not advisable, in some localities, to disturb gravel ballasted track for a general surface later than September, but it is possible to surface in stone ballast until the ground freezes.

(3) Weeding—The weeds and grass on the right of way should be burned over in the fall, before the seeds have scattered. Particular attention should be paid to burning around piling, fence and sign posts in order to prevent them taking fire. The station grounds should be cleaned up also at this time and made as neat as possible.

(4) Repairing Road Crossings and Approaches—Any defective planks in road crossings should be renewed and holes in the right of way should be filled up with suitable material. The foreman should bear in mind that any imperfections left in highways and approaches will leave the road rough during the entire time the ground is frozen.

(5) Flanger Signs—The flanger signs should all be put up in their proper locations, in readiness for the first snow storm.

(6) Ditching—Surface and track ditches should be cleaned out and the material should be carried to places where it may be used to strengthen the weak places in embankments, if possible. The use of the gasoline motor car and dumpy as a trailer makes it profitable to carry dirt a good deal farther than formerly. Ditching is often done by extra gangs, so that in some cases this work would not fall under the jurisdiction of the section foreman. But where extra help is not allowed, the section foreman must do as

much of this work as he can with the available force.

We illustrate herewith a dump car used with a gasoline section car for hauling dirt, where a dirt train would not be justified. The top of the push car is about 5 ft. wide and each dump box is made about seven-eighths of this width, or about 3½ ft. wide. The distance A in the sketch is about 1 in. less than half the width of the top of the car, or about 2 ft. 6 in., and B is about 1 in. more than three-eighths the width of the top of the car, or 1 ft. 11 in. The depth is about one-third the width of the top or the car, or 1 ft. 8 in. The cleats should be nailed on the boxes, as shown, so that the boxes when dumped will not slide off, but will engage the cleat nailed on the dump car. The

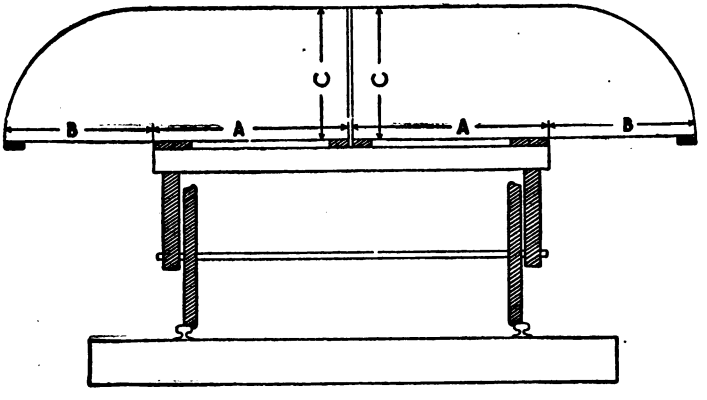


Fig. 15—Dump Boxes for Hauling Dirt.

bottom of the dump box should be made so that the dirt when sliding out will run with and not across the grain of the bottom boards. Dressed lumber should be

used for the bottom boards and painting them will also make it easier for the dirt to slide off.

The material which is taken out of surface ditches on the top of the cuts should be placed where it will not again be washed into either the surface or track ditch. If it is impossible to spare the time to carry the dirt away, the best place to waste it is between the surface ditch and the top of the slope of the cut.

(7) Soft Spots—It is particularly advantageous to drain out all soft spots, water pockets, etc., in the roadbed before winter, as the presence of water in the sub-grade will cause heaving track. Many methods have been followed in draining water pockets, but a description of them would be too lengthy to be included in this book. The usual procedure is to drain by means of French drains, cross tiling, etc. The method used in each case should be governed by the conditions, the method to be specified by the roadmaster or engineer after an investigation has been made to determine just which the conditions are under the track. The foreman should call the attention of the roadmaster to all places which need attention and arrange for the investigation to be made.

(8) Drain Pipes, Culverts, Etc.—All drain pipes, culverts and ditches which cross the right of way should be cleaned out, so that there will be no chance of the water being dammed up. These waterways should all be of such size and kept in such condition that the current will increase as it approaches and as it leaves the roadway. If the current is decreased there will be a deposit of mud, silt and debris which will gradually dam up the waterway. Ditches should be cleaned to the edge of the right of way, and if it

appears advisable, for some distance beyond the right of way line, with the consent of the owner. Clean cross ditches, drain pipes, etc., will prevent the water from backing up and may prevent a washout.

(9) Expansion—On the first real cold day the expansion should be adjusted in a somewhat similar manner to the way it is adjusted in the spring. The joints which are tight up, however, are the ones which should be loosened at this time, so that the rails may loosen and pull apart and thus equalize the expansion. Bolts should be tightened wherever necessary.

(10) Regaging—Regaging can be done profitably during the fall, when other work isn't pressing. Particular attention should be given to those places where no gaging was done in the summer. It may also be possible to turn in canted rails, reset tie plates and do the necessary adzing which these jobs require. All old spike holes should be plugged up.

(11) Repairing Switches, Frogs, Etc.—All switch points, frogs and guard rails which need repairs or changing out should receive attention before winter sets in. Where no changes are necessary these appliances should be given a careful going over, regaging, spiking, bolting and making other necessary repairs. Slide plates and braces should be replaced or straightened, or adzing done to give them a more even bearing.

(12) Snow Holes—Snow holes about 4 in. deep should be dug under switch rails, movable frog points or spring frog rails, and guard rails, so that snow may easily be removed. Wherever possible ditches should be provided for draining these holes out, or in some cases pipe may be used for this purpose. Good drain-

age should also be provided around railroad and highway crossings, water cranes, etc. Ditches should be made rounding and the shoulder dug down level with bottom, leaving the ground in such a condition that there will be no danger of persons stepping into holes and falling. Ballast should be cleaned away from the rails all along the section and around switches, to prevent short-circuiting the signal circuits.

(13) Side Track Repairs and Renewals—On some roads it is the practice to leave the side track repairs and renewals until fall. Although poor practice, second-hand main line ties are sometimes used in side tracks, in which case the renewals should certainly be made in the fall, so that ties taken out the previous summer can be used. There is no economy in using second-hand ties unless they are good for more than three years' service. Otherwise the cost of tie renewals, from 10c to 20c, will overbalance any saving made in using second-hand timber. (The cost of tie renewals can frequently be decreased by using one of the methods described in Chapter XIV, Yard Maintenance.)

(14) Surfacing and Lining—Just before the ground is due to freeze the foreman should run over his section again to surface and line any bad places which otherwise would require early shimming or spike lining. He should bear in mind that any work of this nature done just before the ground freezes will save him many hours' work in the winter, beside giving a better track than if shimmed or spike lined.

(15) Estimates—Estimates should be made of material needed for renewals, including track and switch ties, crossing planks, fence materials, rail anchors, etc.

(16) Portable Snow Fences—Portable snow fences should be erected before there is any likelihood of snow. The location of the fence should be governed by the nature of the surrounding country. For a long slope, the fence should be placed at the edge of the right of way, or even beyond the right of way if permission can be obtained. In other places where the slope is sharp the fence should be placed much closer to the track, otherwise it will be covered with snow after the first snow storm and thereafter do no good.

(17) Winter Tools and Supplies—The foreman should check up his complement of winter tools and be sure that there is nothing lacking when the first snow falls. He should have a full complement of rattan brooms, snow shovels, salt for switches, hand car brooms and broom-holders, track shims, braces and second-hand spikes. He should also have a sufficient number of frost spikes for his requirements.

AFTER THE GROUND FREEZES.

(18) Rail Anchors—Rail anchors should be inspected before the first snow, and those which are loose tightened up so that they will need no more attention during the winter.

(19) Emergency Rails—Emergency rails, with angle bars loosely bolted to them, should be placed on the rail rests. The rail rests should be located at points where the snow is not likely to get so deep as to cover them up. Rail rests should be located on an average of not less than a mile apart. When angle bars break new ones can be obtained quickly from the rail rests. When a rail is used the angle bars can be taken off and replaced on the new rail which is brought out and set up in the rail rests.

(20) Repairing Fences—Light repairs on snow and right-of-way fences may be made after the ground freezes, and when it is impossible to do surfacing, lining or to make renewals. Snow fences properly located and properly erected reduce winter work and prevent traffic delays.

(21) Piling Up Material—Platforms of sufficient height to prevent such material from being covered with snow should be erected, and angle bars, tie plates, braces, etc., piled on them.

(22) Rip Rap—The rip rap at abutments, piers and embankments which are subject to ice gorges, should be inspected and strengthened by rearranging the stones to give the best protection. Where the haul is not too great, rocks taken out of track ditches should be transported to places where rip rap is needed.

Conclusions—The work of the fall months should be confined to that which will make the track best able to withstand winter conditions. The foreman should constantly keep in mind that his track is receiving the last surfacing, lining, etc., for from four to six months and he should take particular pains to see that all the worst places are given attention. Cleaning up ditches and waterways is the most important part of fall track work because drainage is especially needed in winter and spring. Track foremen will do well to constantly remember what one road-master has to say about drainage, viz: "Water is the track's worst enemy and the further it is kept away from the track, the better."

CHAPTER XI.

WINTER WORK.

It sounds strange to say that most winter track work should be done in the fall. But if the track is properly prepared for the winter during the fall months, there will be very little repairing to be done and the track forces will be available, almost continuously, for cleaning snow and ice from the track. Good preparation for the winter means less shimming, and consequently a better riding and safer track. The entire time of the track forces should be available when heavy snow storms come—there should be no small repairs to take part of the men away from where they are urgently needed.

There is a general tendency to increase the scope of winter work, and in the clear weather between storms, to do such work as distributing ties and rails for the following year, adzing rail seats and even relaying rail. The advantage of doing such work in the winter is that experienced men can then be retained, as year around employment is a great incentive for them to remain in the service. And unless weather conditions are unfavorable, a larger day's work can be done than in the hot summer months. Not only that, but when the spring work opens up, the gangs will be well organized, thus saving time and money. Doing work in the winter which has formerly been done in the summer, greatly relieves the summer shortage of track laborers, and there is usually a surplus of laborers in the winter.

The most important winter work is to keep the track open for traffic. A sufficient force, well equipped, should be hired and ready immediately after the abatement of a storm to open up traffic, or if possible, to prevent a tie-up. Additional snow fences may have to be quickly raised to guard against another storm. Plenty of portable snow fences should be kept on hand, in country subject to heavy snow, as trouble is constantly experienced in unexpected places. Conditions are changed almost every year by cutting off timber, etc.

The following outline is not intended to show the exact order in which winter work should be done, but rather to give an outline of many kinds of work which may be done. The order or arrangement of the work depends upon the weather. It may be possible in a late winter to do a lot of gauging before the first storm, while in other years the weather may be so severe as to require the entire time of the gang keeping tracks and switches open.

Winter work can be outlined somewhat as follows:

1. Inspection should be constantly made for:
   A—Heaving track.
   B—Low bridges and culverts caused by embankments heaving.
   C—Spreading of shimmed track.
   D—Wide expansion.
   E—Broken rails.
   F—Broken angle bars or bolts.
   G—Canted rails.
   H—Wide gauge.
   I—Dammed up bridges, culverts, ditches and other waterways.

J—Snow trouble after a storm—cuts, switches and flange ways.

2. Erecting snow fences.
3. Cleaning snow and ice from sidewalks or around stations, shops and other buildings.
4. Shoveling, plowing and clearing snow from main lines.
5. Flanging main line.
6. Keeping switches loosened up and working.
7. Shimming.
8. Cleaning snow from yards.
9. Cleaning out track or surface ditches and opening outlets.
10. Cleaning out bridges, culverts and cross ditches.
11. Renewing and tightening bolts and nuts, and driving down spikes.
12. Gauging.
13. Distributing ties.
14. Distributing rails.
15. Barking ties.
16. Adzing rail seats on ties for next year's renewals.
17. Adzing rail seats to straighten canted or tipped rails.
18. Distributing cinders for branch lines.
19. Repairing and renewing right of way fences.
20. Trimming hedge.
21. Cleaning up rubbish in yards and around cinder or ash pits.
22. Cleaning up ice around water tanks or pen stocks.
23. Cutting brush too large for the scythes.

(1-A, B and C) Inspection—The foreman must con-

tinually look for heaving track and put shims in immediately to prevent broken rails and derailments. The track on bridges and culverts may be low on account of track heaving on the embankment approaches. Such places should be watched carefully and the carpenter gang notified whenever it is necessary to shim up such structures. Where ballasted-deck structures are used, the track foreman will take care of his track the same as that on the adjacent fills. Shimmed track must be watched continually, as it is likely to heave further, or settle during thaws.

(D, E and F) Expansion and Broken Rails or Fastenings—The expansion should be watched as there is a likelihood of rails pulling joints apart. The trouble is most likely to be encountered on bridges where the track is not anchored. A joint which has pulled apart is dangerous and is likely to cause a derailment. Rails are broken more frequently in cold than in warm weather, because the steel is more brittle, and because on account of heaving, the ties are likely not to support the whole rail uniformly. Angle bars or bolts are likely to be broken on account of the contraction of the steel and the resulting strain on the joint.

(G) Canted Rails—Rails are likely to cant and as they tip the gauge widens; it may widen enough to let the wheels drop off the rails. Canted rails can usually be spotted by the marks which the wheels leave on the rails. When they are badly canted the wheels will leave worn places only on the inside of the ball.

(H) Wide Gauge—The gauge of the track is likely to gradually get wider on account of the rail wearing or on account of canting. Whenever the gauge gets uniformly as much as one-fourth inch wide, over a stretch

of track or over the whole section, the track should be entirely regauged. Places where one joint or one rail length are only one-eighth of an inch wide will show up strong and such places should be given immediate attention. Ice decreases the friction of the rails on the ties so that gauge is more likely to widen in the winter than in other seasons. When there is 5 or 6 inches of snow on the ground, the track walker or foreman can easily detect wide gauge by the flange marks which the wheels leave in the snow. When the snow is not yet on the ground the inside spikes on the high and low rail of a curve should be inspected frequently to see whether the rail appears to be pulling away, this being a sure indication that the gauge is getting wide. Wide gauge due to rail canting is not so easily detected. It may be indicated by the inside spikes raising up from the rail. Testing with the gauge is always the surest method, especially when tie plates are used.

(I) Drainage—Ditches should be cleaned out at the beginning of every thaw in order to prevent the water from running onto the track and freezing. Culverts, bridges and other waterways should be watched closely to prevent ice lodging and damming up the stream. Particular attention should be paid to the outlets of ditches and other waterways, and the water turned away from the track and not against embankments.

(J) Inspection After a Storm—After or during a snow storm the foreman should get out over his track and note the condition in all cuts—the number that are drifted full, the depth of the snow and any other particulars which will help the snow bucking crew

when it arrives. The switches at yards should be given constant attention so that any trains which come may take siding without delay. The laborers should be detailed to look after certain switches, it being customary in large yards to assign each man a certain number of switches, the foreman covering the whole territory to inspect the work which is being done.

In making his daily trips over the section, the track walker or section foreman should carefully note any places which need flanging. This work should be done before the snow has had time to be packed down and freeze, for if frozen it is necessary to loosen the ice with picks, thus wasting time and labor.

2. Snow Fences—Where no fences are provided, a good protection can be made with a brush fence. The brush is tied up in bundles and laid with the tops toward the wind. Enough bundles should be laid, one upon the other, to form a substantial barrier which will not be blown away by the wind. A very effective wall may be formed after the first snow has fallen and hardened, by cutting square blocks of snow and piling them up. Or, it is possible to make a temporary snow fence with ties which have been distributed for the following year's renewals. These may be piled up, breaking joints, and ties used as braces. The end of the snow fence should, in every case, be turned in toward the track, so that a quartering storm will not get a sweep directly through the cut.

Snow sheds should be repaired at this time, and loose boards replaced or nailed down; where boards have blown off and disappeared, new ones should be placed, and the sheds made snow-tight.

3. Snow and Ice Around Buildings—Where track

gangs are required to clean the snow off station platforms, this work should be done during a storm as often as necessary, giving this work preference. Around shops and places where numbers of employes must walk daily, every effort should be made to keep the ice cleaned up so that no accidents will result.

3. Clearing the Main Line—If a snow storm leaves deep drifts, trenches 5 to 8 ft. high should be dug every 15 or 20 ft. before the plow arrives, unless a rotary is being used. Trenches will often break up the resistance to the ordinary plow sufficiently to let it go through a cut which would otherwise stall it. Where the snow has drifted in and is 8 or 10 ft. high on one rail, and the other rail has been swept off clean by the wind, the plow is likely to be derailed if the snow gets hard. The section forces should therefore clean off the snow a sufficient distance to give the drift a square face for the plow.

The foreman should figure on giving the plow more clear track on up-grades than on down-grades and he should also bear this in mind when flanging. Where a heavy pull has to be made, the track should be kept carefully flanged out.

When a foreman has men working in a cut, he should keep careful watch and when a snow plow appears give the men warning in plenty of time so that they may get out before the plow strikes the cut. When storms break down telegraphic communication it is impossible to obtain information as to just when the plow train is coming, and then the foreman must be particularly careful to see that his men get out of the way.

4. Preparing for Flangers—After the first perma-

nent snow has fallen, the planks may be taken out of private crossings and cattle guards may be taken up so that they will not interfere with either the flanger or the snow plow equipment.

Flanger cars or flanger plates for locomotives are commonly used, so that after the main line is made passable for the snow plows, the track gangs are not usually required to do any further flanging, except around switches and crossings. Even when the snow fall is too light for heavy or rotary plows, the flangers are found to be of great assistance.

Road crossings and guard rails must be kept flanged out, to prevent the snow and ice from packing, freezing and expanding, and thus forcing guard rails or planks out of place.

5. Switches—Switches will cause trouble and the foreman should keep them cleaned out as well as possible in order to be prepared for snow storms. If the snow holes get full of water and freeze, the first work of the track forces should be to loosen up and clean out the ice. After a thaw, when the water is constantly collecting in these holes, laborers should be detailed to work overtime, bail out the water, and keep the switches open for traffic. Ditches should be dug wherever possible to drain off the water. The use of hydro-carbon or torches of various kinds is justified for melting the snow and ice at switches, in medium sized yards or terminals. Interlocking switches should be given especial attention, for the leverman cannot leave his tower and clean out the snow as trainmen can at hand operated switches. A broom and shovel should be left at outlying switches for the use of trainman.

There are proper and improper ways of ditching around switches. Where possible, each snow hole under the switch rails should be drained by a good ditch, leading out over the bank and the same may be said for drainage of the snow holes under the frogs.

The ditches should be well rounded, or the whole shoulder may be dug down the required depth to give drainage, thus making ditches unnecessary. On inside switches the water should be led to ditches parallel with the ladder which should be run back 100 ft. or more. These ditches should be well rounded so that there will be no bad footing for trainmen and others. The ditches made parallel to the track may have no outlets but they will at least give the water a chance to run away from the frog and be soaked up by the ballast.

6. Shimming — Assorted shims of various sizes should be furnished each year and shipped out in sufficient quantity to all track foremen. Some trackman is authority for the statement that no shims of less than $\frac{1}{8}$ in. thickness are necessary. A $\frac{1}{16}$ in. space under a rail on a very cold day, however, is likely to cause a rail to break. Where shims are not furnished thinner than $\frac{1}{8}$ in. therefore, the foreman should split up pieces of wood and drive them in under the rail in order to give a solid bearing. Shims should be furnished in sizes varying $\frac{1}{8}$ of an inch in thickness and should not be sent out promiscuously, but a certain number of each thickness should be sent out to each foreman. Frequently a foreman will have three or four times as many shims of one thickness as he needs and none of other thicknesses. When shimming, the spikes should be raised on all ties which are to have

shims and the rail seats adzed out wide enough for the shims. The shims may be driven in crossways between the spikes and nailed with ordinary wire nails, or the spikes may be withdrawn, the tie plates removed, the shims inserted and the spikes redriven through the holes in the shims. The track should first be raised to the proper surface and one shim placed to hold it. In putting in the rest of the shims, none should be used which are too thick, as it will raise the track out of true surface.

Tie plates need not be removed for thin shims, the shims being placed between tie plate and rail. For shims an inch or more thick, shoulder tie plates must be removed. Where track has to be shimmed more than ¾ in., it should be side-braced, using tie plates, short pieces of angle bars or wooden shims of the thicker size, which may be set against the web and up under the ball of the rail, with outer ends on ties and spikes driven in the holes. When it is necessary to shim over 1½ in., short pieces of planks should be used with frost spikes, and the planks should be nailed to the ties with boat spikes. In some places it may be necessary to use a plank to go clear across under both rails, bored for track spikes, with ordinary track shims on one side or the other to level up. Tie rods, 3 or 4 to a rail, depending on height of shims, are often used instead of long planks.

7. Yards—The snow should be kept cleaned out to prevent the possibility of an additional snow fall tying up a yard. The snow between tracks should be removed after each heavy snow fall. This may be done either by a spreader working from one track to the other and gradually shoving the snow clear across the yard, or

the snow may be loaded on cars. For removing snow from platforms, or from ladder tracks, boxes may be used, made of inch lumber with handles similar to the handles on a tool box. A large load of snow can be placed in one of these boxes and carried away by two men.

8 and 9. Ditching—A most important feature of track work in winter, is ditching. The ditches through

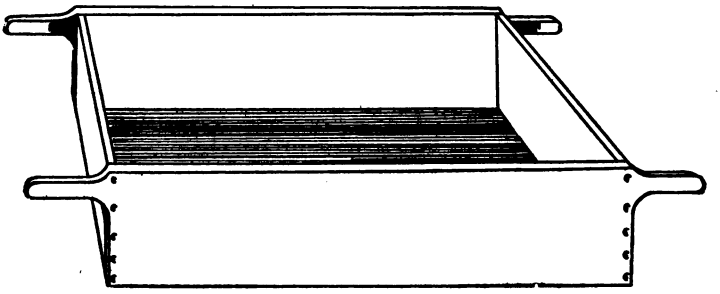


Fig. 16—Snow Box.

all cuts should be kept as clean as possible. At the beginning of a thaw they should be cleaned out so that the water can run off as fast as it collects. Every facility should be provided in yards to prevent the accumulation of water.

Outlets under the track, through the roadbed, should be kept clear constantly to prevent water damming up and raising so that it will be dangerous to embankments.

10. Renewing Bolts and Spikes—When the track is fairly clear of snow and ice and there is a spell of good weather, bad spikes or bolts may be renewed. Bolts are likely to be sheared off by rail creeping, or

by contraction, and thus allow the rails to pull apart far enough to cause a derailment. The gang should also be sent over the section to tap down high spikes. The nuts on switch rods, switch stands, etc., should be carefully inspected and cotter pins placed wherever necessary. Braces and clips on spring rail frogs must be watched closely as the spring rail is likely to get high; if this happens wheel is likely to turn the wing over and cause a derailment.

11. Gauging—As it is almost impossible for the track gang to gauge all of the section in summer, a good deal of gauging is now being done in winter. When the weather is favorable the foreman can start at one end of his section and by doing a little each day or each week he can gradually get his section in excellent shape for the coming summer.

12 and 13. Distributing Ties and Rails—The distribution of ties is discussed under the chapter on "renewing ties" and the distribution of rails in the chapter on "relaying rail." Distribution of these materials should be made without fail in the winter so that it will not interfere with the important work of the spring.

14 and 15. Barking Ties and Adzing Rail Seats—If ties are received with the bark on, the track forces should figure on getting them barked during the winter in order that they may season better and also that the work will not have to be done at the time renewals are made. Rail seats on renewal ties should be adzed, as it is much cheaper and easier to do this work when the tie is out of the track. The Ware tie plate surfacer, or a home-made template may be used to obtain a correct rail seat.

16. Straightening Canted Rails—Where inspection

shows that rails are tipping out, the snow and ice should be cleared away and the insides of the ties adzed down at least far enough to bring the rail up straight. The spikes may then be pulled and the adzing carried under the rail. This work should be looked after carefully in the winter to prevent the gauge getting wide or the rails tipping dangerously.

17. Cinders—Cinders for branch lines should be taken out in train loads, section gangs being doubled up if necessary to unload them in places where they will be needed the following spring and summer. Having these cinders where soft track is likely to develop after the frost goes out, is a great convenience.

18. Repairing and Renewing Right of Way Fences—Some work on right of way fences can be done in the winter, although it is not usually possible to dig fence post holes and set new posts. Wires may be spliced and tightened, gates repaired and other work done on the fences as long as the snow does not become too deep.

19 and 20. Trimming Hedge and Cleaning up Rubbish—Hedge may be trimmed when other work slackens up. Rubbish and ashes should be cleaned up around cinder pits immediately after they are deposited and before they freeze up if possible. Excellent progress can be made cleaning right of way when there is not too much snow.

21. Ice Around Water Tanks—Ice should not be allowed to accumulate around water tanks or pen stocks, as it may cause derailments; and there is always the danger that someone will slip and be injured by a fall, or struck by a train. The same might

be said for ice around stations, shops and other buildings.

Bucking Snow—Bucking snow is a broad enough subject for a book in itself. Conditions are met with which are so varying that it is almost impossible to give anything but general rules in this chapter. Some mention has been made of methods which the foremen may follow to facilitate the work of the plows.

In handling the plows it is usually best to operate them with not more than two engines, with a following engine as a reserve. Then in case the two engines get stuck the following engine can pull them out, after which they can back up and get a fresh start.

In a heavy snow the plow should be operated at a speed sufficient to get through the drift. In a light snow the plow should not be run fast because the snow will simply be thrown up, whirl around and settle again in the rear of the train. The best power available should be used, a speed of 40 miles per hour being necessary sometimes, in a deep snow, to give satisfactory results.

The main thing in being prepared for a snow storm is to have all equipment in working order and so placed that it may be started in motion instantly. Camp, dining and sleeping cars should be fully stocked up awaiting transportation to the scene of trouble, so that after work is once started the gangs will not have to waste valuable hours in going to and coming from work. The foreman should carefully check up his equipment of snow fighting tools and be sure that everything necessary is on hand. Usually the roadmaster should stay in his office and direct the work over the entire division rather than get out onto the

track and look after one particular location, in which case the work on the other parts of the division is likely to lag. But in case there is only one place where serious trouble has developed, the roadmaster may safely go to that spot and stay there as long as necessary.

A trackman with experience in snow bucking and one who is familiar with the track on the division should be placed in charge of the snow plow equipment. The best engines and engineers in the service should be assigned to the work and should report and take orders from the foreman or roadmaster in charge. Fuel and water should be taken at every opportunity and a car load of coal carried by the helper engine. A steam hose should be provided if there is no permanent tank heater with each engine, so that live steam can be conducted into the engine tank to melt snow, should the water become low. Every drift which looks bad should be examined before making a run for it. Safety should always be considered even though it decreases progress. Usually the plow should start out before the storm gets too much of a start.

Ordinary heavy snow plows of substantial design will throw the snow out of an 8 or 10-ft. cut; for deeper cuts a Rotary must be used. Where the snow is too deep for the plow, the tops of the drifts should be shoveled off by the track gangs. Where the drift is deep and the snow hard, it is a good plan to slope the snow off gradually so that the shock of the plow hitting the drift will be lessened.

The engineman, if experienced, will handle the plow so that the least amount of shoveling will be necessary behind it. A flanger should be run in the plow train

or by the helper engine, and the track flanged before the snow has a chance to get hard and freeze. The engineman should sound the whistle often when approaching a drift where section men are likely to be working, while the section gang should always place a watchman to warn them of the approach of the plow train.

Conclusions—While the foreman should busy himself mainly with work which will keep traffic moving, he will frequently find time to do many other odd jobs in the winter, which will help to further his work in the spring. He should remember that it is much better to push his work than to have his work push him, and for this reason should do every possible job in the winter which will lighten his work in the following seasons.

Track foremen should keep roadmasters and superintendents advised of snow drifts, giving depth, length, height, and location. They should also advise where it is necessary to run the dozer, which is a most valuable snow operating machine. Great stress should be laid on keeping this machine ready for operation at all times.

CHAPTER XII.

TRACK WORK IN THE TROPICS.*

In semi-tropical states there are no distinct seasons of spring, summer, fall and winter, and except in the high altitudes there is no trouble from frost or snow. Frost never penetrates more than 1½ in. into the earth, and little preparation for frost and snow is necessary.

Surfacing, tie-renewals and rail-renewals can be carried on throughout the entire year, with the exception of the days when storms are raging. The storms are not the gentle rains of the eastern and northern states. They are accompanied by high winds which are very disastrous to track and roadbed. In the canyons, trees are uprooted and hurled upon the tracks. In the valleys, when the rivers and streams are out of their banks and the low-lands are overflowed, the waves beat against the track embankments and cause serious damage. I have been on work-trains watching for breaks in the roadbed, when the waves would roll high enough to wet the men on the cars, which were loaded with large granite rocks and sacked sand.

Water causes the most serious problems in such a climate, although clearing grass and weeds takes up a very large proportion of the time of section forces.

January Work—In January the main work is to patrol during storms. In the canyons every foot of track must be patroled. Each foreman is required to use rigid discipline in handling his patrolmen, not excusing the least

*I am indebted, for this Chapter, to S. J. Evans, foreman, Southern Pacific Co. (Central California Traction Co.)

infraction of rule or instruction given them. No men are kept who do not supply themselves with rain coats and rubber boots.

At places where slides are likely to occur, stationary watchmen are placed. Patrolmen are given beats of from one to two miles and before each train is due each one must cover his territory from end to end. All track must be patrolled the half hour preceding the time of the train.

For seven years I was stationed on the most dangerous sections of the road and in addition to the foot patrolmen I placed a man on a velocipede car. His duty was to run over the entire section ahead of trains. I made it a point to see all men during the night, sometimes on a train and sometimes on foot, having no specified time. I figured on keeping them guessing as to when I would be along.

When there is fair weather, during a portion of this month, the time is taken up by clearing small slides which obstruct side ditches, and repairing surface ditches on the tops of cuts. A few men are employed in repairing switches and re-gaging curves. It is the custom also to renew and tighten bolts, also to pull and re-drive high spikes.

February Work—In the first days of February the routine is nearly the same as in January. About the middle of the month surfacing is begun, preparatory to renewing ties. One day each week, preferably Saturday, is spent in repairing switches, signs and road crossings. Station grounds are given a thorough cleaning.

March Work—About March first, all section gangs are put at work renewing ties. The ties are distributed principally with push cars. The ties are received during

the preceding year and piled for seasoning at points as near as possible to where they are to be used.

In distributing, the foreman marks with crayon the tie to be removed. Most foremen mark their ties X to renew, and O to inspect when in doubt as to whether the tie is fit for another year's service or not. The O ties are exposed to view, but are not taken out by the laborers until the foreman decides that they will not render another year's service. This method leaves few good second-hand ties; rarely any that are fit for side-track use.

Where curves are numerous, it is the custom (if ties are bad and the track persists in spreading) to first insert two or three ties to the rail. The ballast is dug out from between two ties and the new tie is inserted between them, the old ties remaining in track until the general renewal, which takes place after the curves are placed in perfectly safe condition. This is called "tie skirmishing."

April and May Work—Tie renewals ofttimes extend into the middle of April. Then is begun the first clearing of grass and weeds from the track. This work is pushed diligently until the last of May, when the grass, usually wild oats, begins to dry. Fire-guards are then cut for the fences and around bridges and buildings on the right-of-way. Where the right-of-way is rented for haying purposes, the lease requires the renters to plow three furrows as close to the right-of-way as possible.

June Work—As soon as grass and weeds are dry enough they are burned. Fires must be kept strictly under control to prevent spreading to adjacent property. Fires spread more easily than in wetter climates. Many fires are started by engines and, when high winds prevail,

quite a number start from passengers throwing cigar and cigarette stubs out of car windows.

July and August Work—Every foreman is ambitious to have his right-of-way burned over by July 4th, as on that date many grass fires are started by the careless handling of fireworks. From the first of July until the middle of August general surfacing is given the preference over all other work. From the middle of August until the annual inspection, which usually comes in the first part of September, the time is occupied in trimming up ballast and a general cleaning up of stations and station grounds.

September, October and November Work—After the inspection, all water courses are examined and weak places in the ditches are strengthened. In the canyons the side slopes are inspected and the loose rocks are removed from places that are likely to slide during the following storm period. The summer suns have a penchant for cracking and loosening the rocks of this section of the Pacific slope; rocks that look firm and well set early in the year, will be found to be cracked and ready to slide during the months of October and November. All of this rock is worked down and piled to the sides of the track ready for loading upon a work train and is used in strengthening weak places.

December Work—December is usually given over to repairing fences, cattle guards and road crossings, also cleaning culverts preparatory to the storm period. Extra gangs are employed the year round, in ballasting, relaying rail and the laying of industrial tracks.

CHAPTER XIII.

YARD MAINTENANCE.

Standard of Maintenance—Yard maintenance differs materially from section maintenance in many features. The yard foreman should first of all bear in mind that yard tracks do not have to be kept in as good shape as main line track; and to insist on such a high standard is a waste of money. While the track should be kept absolutely safe, it is not economical to keep the track in condition for 50-mile-an-hour traffic where 15 miles an hour is the highest speed.

While a high standard of maintenance, such as is necessary on main lines, is not necesary in a yard, still the materials—rails, ties and rail fastenings—will last much longer if the tracks are kept in reasonable line and surface. The extra labor necessary to do this is highly justified by the increase in the life of materials alone, and there is a still further saving through the elimination or reduction in the number of derailments. The materials in tracks which are badly out of line and surface are destroyed much more quickly than most track men realize.

Yard tracks should be laid out on tangent if at all possible, and this is particularly true because, on account of financial or business conditions, the maintenance is likely to be slighted for long periods. Curves increase the cost of maintenance excessively and also increase the likelihood of derailments.

Dividing the Gang—In yard work, the gang should be divided, and small jobs, such as adjusting switches, repairing switches when run through, replacing bolts or

angle bars, and adjusting and renewing foot guards, should be done by a handy man, or by an assistant foreman. This leaves the foreman free to look after the heavier work of replacing ties, surfacing, and general cleaning, in which the larger part of the gang will be engaged.

In any large yard, a night force of one or two men should be allowed, so that necessary emergency repairs may be made quickly, and without the necessity for calling the foreman.

Ladder Tracks—The ladder is the most important part of the yard. If it is out of order, practically the whole yard is out of service. The importance of keeping the ladders always in the best working condition is therefore apparent. The maintenance cost on a ladder track is high where there is heavy traffic, even if the ladder is well ballasted. If the ladder is poorly ballasted, much more work is necessary to keep the ladder track in service.

Poor surface on ladders is much more likely to cause derailments than poor surface in yard tracks. The curved leads are usually quite sharp, much sharper than is ordinarily used in main line switches. Furthermore, it is not possible, or at least not usual practice, to attempt to elevate the outer rail of the lead. For these reasons derailments are much more likely to occur from imperfections in the surface of ladder tracks than they are on tangents, or on curves which can be elevated.

In fact, there is every reason for ballasting a lead and keeping it in the best possible surface, even where the yard tracks cannot be kept up in good condition.

Overhauling a Yard—Some officials, in arranging to have a yard overhauled, order the foreman to start at one side and raise each track in turn out of a face. This

is not the best policy, because frequently the foreman is unable to get over the entire yard, and thus he may raise and make renewals on some tracks, while others further along are in worse need of repairs. The foreman should be allowed to exercise his discretion and work over the worst tracks first; after this is done he should then start at one side of the yard and raise the remaining tracks out of a face as far as time allows.

The following discussion indicates, in a general way, the order of the work on a section during the four seasons. It is advisable in yard work as in section work to start renewals as early in the spring as possible after the frost has gone out. When the weather is mild, it is profitable to do relaying in the winter and thus decrease the spring and summer work.

Spring Work—The principal work in spring is to keep switches free from water and ice so that switching traffic will not be delayed. Constant attention to drainage is necessary. Wherever possible, open ditches should be dug to drain the water away from snow holes around switches and frogs. These ditches, if deep, should be covered with boards, car doors, or other lumber which is handy, so that the footing will not be dangerous for switchmen and others, and also to keep them free from rubbish. Where there is no outlet for ditches, the snow holes should be bailed out every night and the ice should be thrown over the bank or scattered back of the frog so that water will not run back into the snow holes after the ice melts. On inside tracks it is often necessary to load the ice into any empty cars which happen to be handy.

Every large yard should have a sewerage system, with manholes located at each switch. The catch basins

should be inspected and cleaned out often in the spring so that they will not freeze or get clogged up. A plentiful supply of salt should be kept on hand and scattered around switches and frogs, when necessary, to melt the ice off the ties.

As heaved tracks settle, uneven places may develop in the ladder tracks, causing switches to bind. The frost going out under the yard tracks is likely to develop uneven track and cause rail breakages. Such places may require additional temporary shimming. Where wet spots develop, the holes should be shimmed up, if possible, until the ballast dries out.

Where there is no support for the ties in mud holes or at churning joints, the old mud should be shoveled out at least to the bottom of the ties and cinders used to raise the track on. Frequently the mud will ooze up between the ties as high as the rail. Cinders are very effective in drying up wet places. Dry gravel can be used if cinders are not available.

The leads in the ladder tracks are likely to cause trouble at this time of the year. The ties will be slippery from water or ice and the gage is likely to get wide. This is also true of curves in yard tracks. The gage is also likely to loosen at the switch points and cause a derailment. The ties, besides being slippery are wet and softer and therefore present less resistance against gage widening.

Scrap which has accumulated during the winter should be gathered up and piled at convenient points for loading into cars. Usually the roadmaster will give orders to have all scrap picked up by a certain date. Track scrap consisting of spikes, bolts, nut locks, as well as car scrap

of all kinds, should be picked up and carried to the scrap bin.

In most yards where there is any considerable amount of business, it is necessary to divide the yard up into districts and assign men regularly to the work of keeping these districts clean. This makes each man responsible for the yard under his jurisdiction and makes it easy for the foreman to check up and see that each man is doing his work. If the cleaning is done by the whole gang it will not be done as well nor as often as desirable.

Dirt, ashes, cinders and all other accumulations should be removed and the yard kept perfectly clean. Any laxness on the part of the foreman will soon result in the cleaners neglecting or only half doing their work.

Track barrows are very handy for use in this connection, where there is a track which is free of cars and which can be used regularly. In many yards, however, a track barrow cannot be used and the ordinary wheelbarrow is about the only thing which can be handled.

Hand boxes for carrying snow and ice, described in the chapter on Winter Work, are also useful for carrying out rubbish along ladder tracks.

Spikes and bolts which have loosened during the winter should be tightened and another inspection given to the entire yard, special attention being given to low places in ladder tracks. Shims may now be removed from churning joints or mud holes and these raised and good ballast put under. After the frost is out, the surface ditches should be filled.

Tie Renewals—Where yard tracks are to be surfaced, tie renewals in those tracks should be made when they are raised, as renewals may be made much more easily and cheaply in that way. On storage tracks for cars only,

ties are sometimes kept in until there is almost nothing left of them. At such places the best method is to raise the track with jacks, knock the ties off with spike mauls, clean out and dig down, and then place the new ties under the rails. The track may then require some surfacing, but by this method the foreman can accomplish a great deal of work and leave a better track than if he makes the renewals in the ordinary way.

For yard tracks the exact number of ties for a day's work must be distributed each morning. At night all old ties must be picked up and carried out, so that there will be no danger of trainmen stumbling over them and being hurt.

If the number of ties to be renewed per rail length is large (it usually is) the best way to make renewals in yard tracks is to obtain permission to block the track. The spikes should then be pulled from the few sound ties and the track jacked up with the unsound ties hanging; the latter can be easily knocked off with spike mauls, after which they may be pulled out, the beds dug down and the new ties placed. The new ties are dug in low enough so that the rails, when dropped, again rest on the old ties, the original surface thus being maintained. The new ties are then nipped up, spiked and tamped. Some new ties will be low enough on the old beds without digging down, but this is not often the case, the old ties usually being much thinner on account of rail cutting.

When it is inexpedient to block a track, the old method of digging-in one or two ties at a time is used; or a few spikes may be pulled on adjoining ties, the track sprung up, the old ties pulled out, the beds dug down and the new ties placed, thus requiring little side digging. Renewals should be made on a running (run around) track

first. Then permission should be obtained to make the running track a storage track for the time being and to use an adjacent yard track for the run around track. Thus, by using storage tracks in rotation for run around tracks, all renewals may be made on an open track under traffic. Track ties in the ladder track may then be removed under traffic as in main line renewals.

Ladder tracks can seldom be abandoned and the old method of digging out and putting in one or two ties at a time may be the best one to use, especially if the ladder is in constant use. Renewals under heavy traffic can be made in sets more easily than singly, but serviceable ties should not be removed. If all the ties are nearly gone, however, it is uneconomical to leave a half dozen for renewal the following year.

In renewing a whole set, the switch is stripped out after having distributed the new set ready to be placed in the track. The ties should be numbered from one end of the switch to the other, according to their lengths in feet and inches. The space marks on the rails should have corresponding numbers, thus assuring that each tie will be put in where it belongs. The ballast should be stripped out to the bottom of the ties and six inches beyond the ends, and the spikes ahead of the switch point and back of the frog should be raised so that the rails may be jacked up without lifting the track ties off their beds. The spikes may then be pulled on 3 or 4 ties, the track jacked up, the old ties pulled out, the new ties put in, the jacks dropped, and the track spiked safe for traffic. Or the new ties may be pulled in between the old ones and spiked before the old ones are withdrawn. This method makes it possible to utilize a period of only three or four minutes between switching movements.

Summer Work—During periods of slack business ladder tracks should be surfaced in preference to everything else. More can be accomplished with less delay and the inside tracks can be raised when business is heavier. In surfacing yard tracks a method may be used similar to that described for renewing ties—surface the running track first, then use the running track for a storage track; use one of the yard tracks for a running track and surface it. If it is possible to get a track abandoned it is advisable to make tie renewals at the same time the surfacing is done, as this cheapens the work considerably.

In surfacing, as in other yard work, the foreman should always remember that he is not working on main line and that the tracks are not required to be maintained in high class shape. He should therefore attempt to do the work with all possible speed—making track serviceable rather than splitting hairs on lining and dressing up. Tracks with mud holes in them should be surfaced first. Where a track is to be relaid, tie renewals should be left, if possible, until the time of relaying. This will prevent respiking new ties. If renewals must be made before relaying, the new ties should be tamped up to the rail but just as few of them spiked as are absolutely required to hold the track to gage; the remaining ties to be left unspiked until the new rail is laid. This not only saves the ties but decreases labor.

The new rail should be laid on the old ties, using one of the ordinary methods. In some locations rails may have to be handled in the same way as ties, enough being taken out in the morning for a day's work, and the old rails picked up each night and carried to a place where they can be piled outside of the yard tracks. Usually,

however, new rails may be distributed beforehand and laid along close to the ends of the ties.

Fall Work—The foreman should run over his yard in the fall and pick up any particularly bad spots which have developed since the summer work. This will decrease shimming and broken rails in winter. The foreman should check up on the yard cleaners, so the yards may be cleaned up before the first snow, particular attention being paid to ladder tracks. In some places dirt, cinders and other rubbish will accumulate almost to the top of the rail; this if left until winter would make it difficult to keep the tracks in shape for use. Old ties and rubbish should be burned or otherwise disposed of. Rails, switch points, frogs and car scrap of every kind should be loaded at this time.

A very neat and serviceable scrap bin can be made of ties and planks. The ties may first be laid down for stringers for 2 bins 8 ft. square, and a flooring of plank or a solid floor of ties used. The sides and back can be made 4 ties high, ties being drift-bolted together. The fronts of the bin can be left open so that the scrap can be thrown in or shoveled out easily. Back of these bins a platform may be laid on which to place large pieces of scrap, the bins being intended for spikes, bolts, nuts, nut locks, etc.

Frogs, switches and guard rails should be carefully inspected and renewals made where necessary. Little of this kind of work should be left for the winter, at which time renewals are not only more difficult to make, but time is seldom available to devote to this without neglecting the more important work of keeping the tracks clear of snow and ice.

Before the ground freezes, snow holes should be dug

under switch rails, frogs and old type guard rails, giving especial attention to spring rail frogs. It will also be necessary to dig out snow holes under mechanical interlocking cranks, compensators, etc. Wherever possible, a ditch should be dug to the snow holes so that the

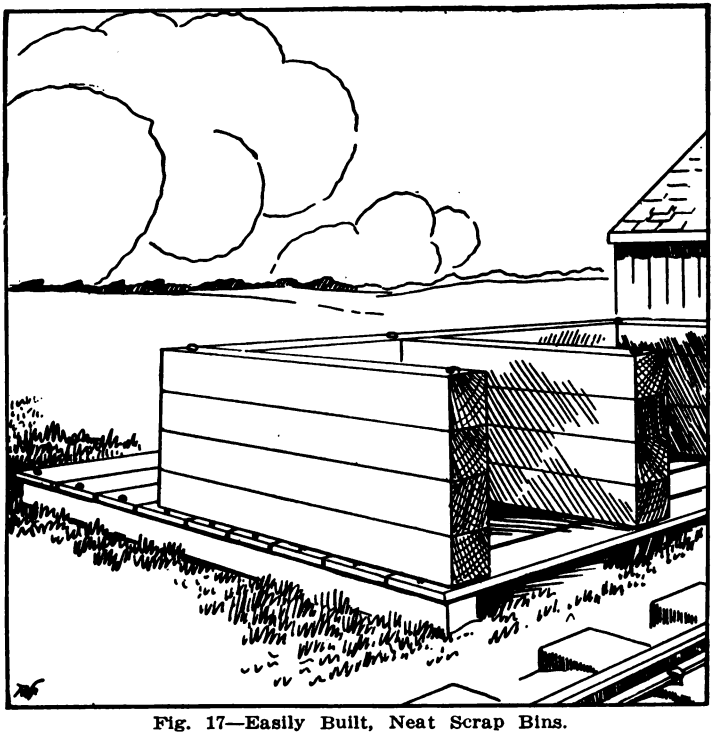


Fig. 17—Easily Built, Neat Scrap Bins.

water will drain away from them. At frogs it is frequently possible to drain the snow holes by digging out half way to the bottom of the ties clear across to the outside rail and then down the bank.

The foreman should check up his tools and see that

there are plenty of sharp picks, sharp bars, salt, rattan brooms, snow boxes, hydro-carbon and any other material which winter work is likely to require. These tools and supplies should be ordered early enough so that they will arrive long before the first snow storm.

Winter Work—Before the first snow the men should go over the yard and ladder tracks looking for loose bolts, driving down high spikes and regaging wherever necessary. As the frost gradually penetrates, trouble is likely to be experienced with the ladder tracks from switch points binding, caused by heaving—the lead or rail ahead of the point may heave and leave the heel of the switch rail low. To prevent this, shimming will have to be resorted to at the heels of switches and ahead of the points. All leads should be well ballasted to prevent heaving as far as possible.

Even in a large yard the foreman should know and keep in mind the exact location of every switch without having to refer to a diagram. Then when a snow storm requires the hiring of extra men, the foreman can assign the men to their locations before they leave the tool house, sending out a bunch of green men with one of the old section hands, telling him what switches he is to keep clear. If more laborers are obtained after the original assignment is made, a few additional may be sent to each location. By assigning the men in this way the work will be started without delay. The foreman should then constantly patrol the yard, and if he finds that there are too many men at some places and too few at others, he can rearrange the force.

Switches should be cleaned out ½ rail length ahead of the switch points and about the same distance behind the frog, so that any snow which is dragged along by

locomotives and cars will be dropped before it gets to the switch proper.

The guard rails on ladders should be watched carefully at all times, as they are likely to get loose or be tipped over and become practically useless. The danger is much greater in the winter, however, as snow and ice, if left to accumulate, will become packed between the guard rail and track rail and will thus tend to wedge the guard rail out. Furthermore, if water lodges between the rails and freezes, it will expand and increase the pressure tending to tip the guard rail over.

For these reasons guard rails should be kept clean; snow or ice should not be allowed to accumulate behind them. During a storm the snow holes under the guard rails should be kept just as clean as those under the switches, if men are available to do the work.

When the snow gets too high between yard tracks a snow train is usually called out, although a ballast spreader has been used for this purpose to some extent. In passenger terminal yards where space for piling snow is limited, it will probably be necessary to put on the snow train immediately after a snow storm starts, but in freight yards the train can usually be dispensed with until after the storm is over. In coach yards there is little space between the tracks and usually that is occupied by sidewalks which must be kept clear, while in the freight yard there is likely to be very little walking around between the tracks during the storm. Particular pains should be taken to clean out snow holes and snow from under the switch stands and connecting rods, because a little ice will prevent these from working. For the same reason, whenever a thaw occurs, the water should be bailed out or drained away from switch

stands. If ground type switch stands fill with water and freeze it is exceedingly difficult to loosen them up, it being frequently necessary to build fires around them and melt the ice out. Salt may also be used for this purpose and is frequently required for use on ties under the switch rails and frogs.

Scale platforms must be very carefully cleaned of snow and ice. Water accumulating and freezing in the crevices in scale platforms is likely to cause inaccurate weighing. Water freezing in scale pits will put the scale out of operation.

Conclusions—It is harder to work to a definite program in yard maintenance than it is in section maintenance. On account of the character of the traffic it is frequently harder to get a few minutes on tracks, especially on ladders, than it is to get time for work on the main line. While the foregoing description covers the work which is possibly most important, there are a number of things which must be given first attention in all seasons, notably broken or canted rails, defective switches or switch appliances, broken bolts or angle bars, etc. Tie plates or rail braces can be applied, frogs and switches renewed, angle bars changed, bolts renewed, spikes driven down and crossing planks reset in favorable winter weather.

If the foreman has also to maintain several miles of main line, the outlines given on section work should be followed where conditions warrant. If the yard is large an assistant foreman will be an economical necessity. Usually the assistant should be assigned work in the yard, although occasions will frequently arise when the foreman will want to supervise the yard work and send his assistant out on main line work.

Very large yards have to be broken up into several sections, supervised by a general foreman and several foremen, or by several foremen working directly under the roadmaster. The best plan is to put the supervision in charge of a capable general foreman—a man capable of filling a vacancy as roadmaster. This centralizes authority and is more likely to keep the entire yard in fair shape, besides giving the general foreman most excellent experience for a roadmaster's position.

CHAPTER XIV.

RAPID IMPROVEMENT OF A SECTION

A track is no stronger than its weakest point. It is better to have uniformly fair track than to have stretches of excellent track mixed in with sections of poor track.

It is occasionally necessary to assign a new foreman to a section for the purpose of making a rapid improvement in the condition of the track, to insure safety or to bring it up to the required standard. There are many reasons for poor condition of a track, among which might be mentioned lack of or poor labor, an incompetent or neglectful foreman, curtailment of appropriations for track work, track on a new grade, or emergency work such as washouts, whereby the section forces have been diverted from their regular duties.

The New Foreman on a Section—When a New foreman is given a section which has been improperly maintained, he will find enough work for ten gangs of the size he is usually allowed. Nevertheless, he will generally be expected to restore the track to the required standard without even the help of an extra gang. Even if an extra gang were furnished, it would be necessary for the section gang to follow out a program of rapid improvement for the entire section in advance of the extra gang. One of the first things the foreman is likely to find is that the track needs surfacing out of face. However, there will be some places which are rougher and need attention more than others and the foreman should make it a positive rule to give all the bad places attention first. Track, like a chain, is no stronger than

its weakest link. It is better to have uniform track in fair condition than to have stretches of good track mixed in with stretches of poor track.

Skirmishing—It is very difficult for a section foreman to do this kind of work, which one supervisor has aptly called "skirmishing." As a rule, section forces, both foremen and laborers, are trained to be thorough, keeping in mind quality rather than quantity. For instance, they are accustomed to tamp track with tamping bars or picks, dress it up, line up the shoulder and ballast line and leave everything in first-class condition. Another reason why a foreman dislikes to run over a section hurriedly, spotting out only the worst places, is that a good foreman takes pride in his work and will be careful to leave nothing behind him which could be criticised by another good trackman, or which he is not proud of himself. Sometimes the foreman will even go so far as to neglect or ignore the orders of the roadmaster, who is constantly riding over the track and is therefore able to locate the roughest spots, or he may postpone fulfilling his superior's instructions until he has completed the job he is working on. This is a great detriment to the work in most cases and should not be allowed; to prevent it the roadmaster should check up carefully to see that his orders are obeyed immediately. On the other hand, there are many foremen who would improve the section quickly and do only the work which requires immediate attention if they knew just what was necessary or had had some experience in this class of work, and it is believed that the following hints may be of value to such men.

First Inspection—The first thing which a foreman should do on taking over a new section is to walk or

make a trip over it on a hand or motor car, to familiarize himself with the conditions. When making this preliminary inspection he should look carefully for dangerous places in the track, such as low joints on the high sides of curves, low bridge approaches, poor alinement at highway and railway crossings, the condition of switches (especially facing point switches), low joints alternately on one side and then on the other, skeleton track or track without a shoulder, churning ties, etc. He may be able to make the first inspection thorough enough to make recommendations regarding water pockets, slides, or soft spots in cuts. He can then order the ballast or other materials necessary to put the track in a safe condition.

In subsequent trips the foreman should ascertain the location, degree, and proper elevation of all curves, the numbers of frogs, location of water ways, the weight and type of rails, both in main and side tracks, type of rail joints, etc. Then he should check his emergency supplies to see that he has a sufficient quantity and to be sure they are the right size.

Laying Out Each Day's Work—The most important part of the foreman's duties is to lay out the work in the order in which it is to be done. If the entire section is to be covered in ten days, for instance, the foreman should divide his section into approximately 10 equal parts, using natural division points such as bridges, crossings, etc. It may be necessary to lay out unequal sections because some parts of the track may require much more work than others. The foreman should determine, however, to cover his entire section in not more than ten days—seven days would be better. When raising bad spots, the foreman will find it advantageous to walk ahead of the gang in the morning with a piece of chalk,

leaving the gang in charge of an assistant, or first raising enough joints to keep the men busy while he is gone, marking the joints which he wishes to raise by two crosses on the base of the rail, one on each side of the joint, locating these crosses so that they will include between them all the ties that it is necessary to tamp. After the foreman has marked off the places which he intends to cover that day, he should return to the gang immediately.

Organization and Distribution of Laborers—As it is only possible to employ a few men when beginning any piece of work, for instance in surfacing, it is advisable to take part of the gang ahead while there is still some dressing up to be done, leaving the remainder of the gang to finish. After a sufficient amount of track has been raised, the remainder of the gang with the exception of possibly one man may be brought ahead. In this manner all the men can be kept constantly at work. The same holds true when lining up a highway crossing. As it will be impossible to employ all of the men in taking up the crossing planks without carrying an unusually large number of lining bars, pinch bars, etc., the work of tearing up should be done by a couple of men while the others are finishing up the preceding job. Likewise, after the low joints have been raised in a crossing and it has been lined, all of the gang save two may be taken ahead, leaving these two to replace and spike down the planks and do whatever dressing is necessary.

Spiking and Gaging—Wherever a little gaging is necessary, a couple of men should remain to do this work, though they should if possible be kept in sight of the foreman. It may sometimes be necessary to take

a good share of the gang out of sight of two or three of the men—for instance, around a curve in a cut—and in this case the foreman should leave men whom he can trust to keep at work while not under direct supervision.

Curves and Bridge Approaches—The curves of course, will require prompt attention. Low joints, in the high side of the track especially, may cause a derailment, and wide gage is more often found and is more dangerous on curves than on tangent. If the track is not tie-plated, it will be possible, during the preliminary inspection, to spot cases of wide gage by noting places where the outside rail has drawn away from the inside spikes. Bridge approaches will almost always require some attention and they should be raised for a distance of at least 100 ft. or more back from the bridge, rather than only one rail length as is frequently done. The track should be raised one or two inches higher than the bridge, particularly if the embankment is settling rapidly, so that it will be unnecessary to give the bridge approaches further attention until after a storm. The foreman should be careful when raising bridge approaches not to run too far back on the track (as he will often be tempted to do because the track is rough), but must remember that there are other places which are in greater need of attention.

Highway Crossings—Usually the track through highway crossings is neglected because of the extra work involved in taking up and replacing the planks; when a section has deteriorated through any of the causes previously mentioned, usually the crossings will have suffered severely. The foreman should be careful to take out the local kinks at the crossing, but should also be sure that the track lines up properly with the tangent for

some distance each way before he puts down the planks again. The same might be said of railroad crossings, but as it takes a long time to line these up correctly, it would be best to let them remain until after the preliminary work on the entire section has been done, unless they are very badly out of line.

Scanty Ballast—Wherever there is a piece of skeleton track, or a lack of ballast on the shoulder, the foreman should correct these conditions at the earliest opportunity as sun kinks are likely to develop and cause wrecks. The quickest remedy is to order gravel in center-dump cars and spread it just as soon as it arrives. It will not be necessary to dress off from the center to the shoulder immediately, as the weight of the ballast on top of the ties will be sufficient to hold the track.

Churning Joints—Churning joints are quickly discovered by a good trackman and will receive his attention in running over the track for the first time, because he knows that the seriousness of the condition does not show up in a case of this kind except when a train is running over the joint. A churning joint may appear to be only a half inch low, but since it has no foundation it may sink 2 inches or more when the wheels of a train pass over it. Churning joints should therefore have early attention.

Bad Ties—Frequently a very large number of tie renewals will be necessary, and the foreman's inclination will be to make the renewals complete where there are a large number to come out per rail length. But if the track is unsafe, he should run over the section, putting in just enough new ties to make the track safe —2, 3 or 4 ties per rail length.

Summary—To summarize, the preliminary work of a foreman on a new section should be confined, first, to places which are actually dangerous, and second, to such other places as are in particularly bad condition compared with the rest of the bad track on the section. The foreman who will pocket his pride and quickly improve the worst spots will probably escape the censure of the roadmaster and higher officers and gain for himself credit for having improved the track materially in a very short space of time.

LABOR SAVING TOOLS AND APPLIANCES.

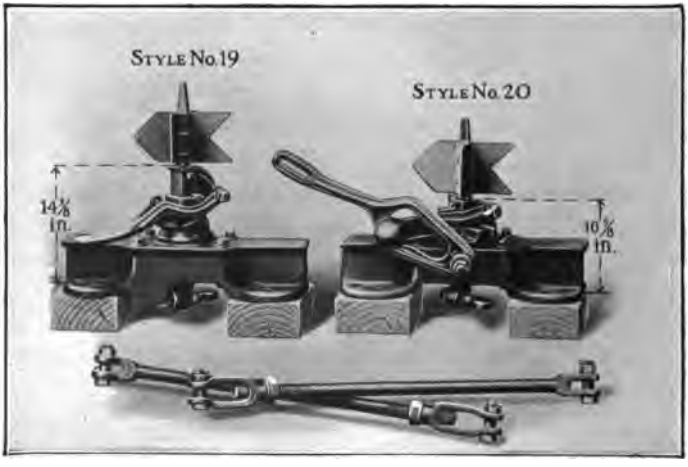
RAMAPO AUTOMATIC SAFETY SWITCH STANDS

The maintenance of large yards is undoubtedly one of the biggest problems which occur in the track department. The yard foreman must supervise a large territory and must have his men scattered over all parts of it in order to keep things in repair. A great deal of trouble is caused by switches being run through by careless trainmen or in some cases by green switchmen who are not used to the appliances.

Recently yard design has undergone a change in places where land is valuable, and has resulted in some rather complicated layouts. In some yards intermediate switches are run off behind the frogs of the ladder switches in order to save space, and this brings the switch stands close together, and frequently causes confusion in the minds of the trainmen, so that the wrong switch is thrown.

In a yard of this kind which has recently been taken over by the operating department, it is not an extraordinary occurrence for 10 or 12 switches to be run through during one night. The track foreman, with ordinary rigid stands, will more than have his hands full the following day in getting the ladder tracks in shape for traffic. Further, there is always the chance that a switch will be run through and not reported and a following train derailed, causing the additional expense of a wrecking crew, destroying part of the ladder track and requiring its complete rebuilding, in addition to blocking traffic on a good share of the lead for one or several days.

Ramapo Automatic Safety Switch Stands were designed to eliminate this trouble. They are made rigid for hand operation, and the switchman can throw the switch by simply raising the handle, thereby releasing the spindle from the automatic mechanism, but the handle cannot be lowered or re-locked until the switch points are fully thrown over.



Ramapo Automatic Safety Switch Stands.

A train or car can trail a switch when set wrong without breaking the switch points or injuring the switch stand. The first pair of wheels forces the switch points open by compressing the springs in the switch stand, and when half-way thrown, the springs snap the points the rest of the way. The stand is left locked in the new position just as if thrown by hand, and is again ready for either automatic or hand operation. All Ramapo Safety Switch Stands are

furnished with adjustable throw and adjustable moving rods, unless otherwise ordered. Adjustable switch rods are not required, as either switch point can be adjusted. The throw can always be adjusted to suit that of any switch, one-half turn of the eye-bolt crank effecting a throw of 1/12 of an inch. The distance of the stand from the switch can be readily adjusted with the adjustable moving rod without moving the stand on the ties. With this stand the points are always locked closed in either one position or the other, whether the stand has been run through or not.

With a rigid stand one of the parts is either broken or the stand is sprung when run through, so that the switch points are no longer left in safe condition for the following trains.

With the Ramapo Automatic Switch Stand the points can never be left in such position, or affected by trains running through them, so that a following train can possibly be derailed.

The adjustable switch stand and connecting rod should be adjusted as follows: Case 1: When the near point fits properly against the stock rail and the far point throws too hard, the throw and also the connecting rod should be shortened. Case 2: When the near point fits properly and the far point does not throw far enough, the throw and the connecting rod should both be lengthened. Case 3: When the far point fits properly and the near point throws too hard, the throw should be shortened and the connecting rod lengthened. Case 4: When the far point fits properly and the near point does not throw far enough, the throw should be lengthened and the connecting rod shortened. Cases 5 and 6: When both points throw too hard or too loose, the throw should be either shortened or lengthened without changing the connecting rod.

THE FAIRMONT BALL BEARING ENGINE FOR MOTOR CARS

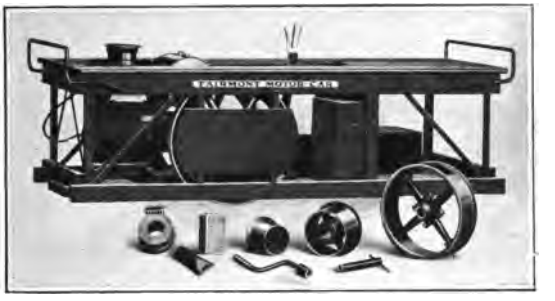
Every foreman who is interested in his own advancement is looking for methods and appliances which will help him to do his work in less time, which will enable him to do more work and put his track in better condition, and thus attract the favorable attention of higher officials. In just what way does the use of a motor car help such a man?

First, the use of a motor car gives the track gang from an hour to an hour and a half more time on actual track work during every working day. This makes it possible for the track foreman to greatly increase the amount of

The Fairmont motor engine mounted on a plank ready for installation on a handcar platform and running gear.

work accomplished, and the extra time which can be spent on his track soon shows in the track's improved condition.

Secondly, the use of a motor car enables the track gang to start work in an alert, refreshed condition, not tired from a long, dragging pump on the hand car. Naturally, this means an increased production from the track gang



Fairmont type power deck which includes the Fairmont type motor and the frame or housing for protecting the motor and seating the men.

per hours of time worked. Thus the foreman is enabled by the use of a motor car not only to get in more hours on actual work, but to obtain a greater average of work per hour.

Thirdly, equipping a section with a motor car enables the foreman to hire intelligent, skillful men—men who will not wear themselves out pumping a hand car.

Making pleasure out of any part of the trackman's work —and a motor car ride on a crisp morning changes drud-

Fairmont type section car complete.

gery to pleasure—is bound to make the job appeal more strongly to the prospective laborer.

In fact, there is no longer any question as to the desirability of having a good section motor car, from the standpoint of the track foreman, without considering the interest of the railroad at all; and a foreman who buys a Fairmont engine and puts it on his old hand car becomes much more valuable to the company than the foreman who doesn't. He attracts favorable attention to himself in two ways: (1) by his enterprise and initiative, and (2) by the marked

Fairmont Pulls Load and Men Easily.

improvement which shows in his section because of the better work and more work which he is obtaining from the same number of men as before.

Section motor cars made by equipping hand cars with Fairmont engines are now so common in most parts of the country that the old-style hand car is considered a mark of unprogressiveness. Over 800 railroad companies have adopted the Fairmont for driving their section cars,

The Fairmont doesn't balk when called upon to pull this load.

and on hundreds of other roads foremen are buying them on easy payments. Since nearly all railroads now furnish gasoline and repairs, foremen have no expense above the small engine payments, which are soon completed.

We give below some of the reasons why the Fairmont has proved a most satisfactory investment for track foremen: It is the only motor car engine which has a crankshaft equipped with self-aligning ball bearings; it starts easily and runs well in the coldest winter weather when other cars are little used; it has a genuine automobile car-

The ball bearing crank shaft used in the Fairmont type motor car—the first to use this improved bearing.

buretor that keeps the engine running right without expert adjustment; it has no poppet cylinder valves or complicated mechanism to wear out and give trouble; it uses less gasoline, going 40 miles on a gallon where few cars can make 25; it has so few parts that anyone can understand and run it; it runs just as well backward as forward, which saves turning the car; it can be instantly reversed without leaving the seat; the sliding base tightens the belt perfectly without loss of power from an idler pulley; the engine runs smoothly no matter how slow it is throttled down; it pulls heavier loads on trailers than cars of three times as much rated horsepower, and starts and hauls them with the high-speed pulley; the castings are 30% steel, twice as strong as common semi-steel, making the engine more durable and much lighter to lift off the track; vibration and shaking of the car, the great fault of most engines, is done away with by using two flywheels, a properly proportioned bore and stroke, and light, finely balanced reciprocating parts.

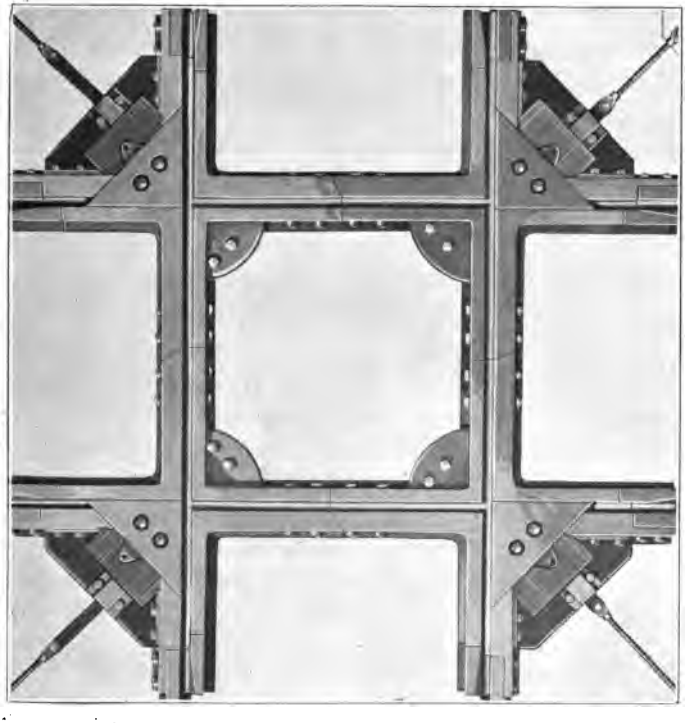
In old types of motors a bronze or babbitt bushing was used for the main bearings on the crankshaft. As this wore, a greater clearance developed around the crankshaft, and the fuel charges had an opportunity to leak out, a condition which grew worse with the age of the motor. Ball bearings and automatic packings eliminate all wear and fuel losses, hence we have more power for less fuel all the time, and there is no drop in power as the motor gets old.

The Fairmont engine has an original design fully protected by many U. S. and foreign patents, which gives an engine whose simplicity, lightness, power, smooth running, and fuel economy are unequaled. It received the highest award, a gold medal, for railway motor cars, at the Panama-Pacific Exposition, San Francisco. These engines and

cars are made by the Fairmont Gas Engine & Railway Motor Car Co., 451 N. Main St., Fairmont, Minn.

EYMON CONTINUOUS RAIL CROSSING.

The soundness of the principle of the movable triangular block, as embodied in the Eymon Crossing, and the



Eymon Solid Cast Manganese 4-piece crossing.

practical advantages of this type of crossing in providing a continuous-rail for the passage of traffic over steam

road intersections, have been proved by one road dating from May 25, 1914, and on others for nearly as long a period. The saving in the cost of maintaining the roadbed at the crossing, the multiplied life of the crossing structure itself and the avoidance of the injurious effects of the open flangeway itself upon the equipment, have been demonstrated at each of the installations of this type crossing.

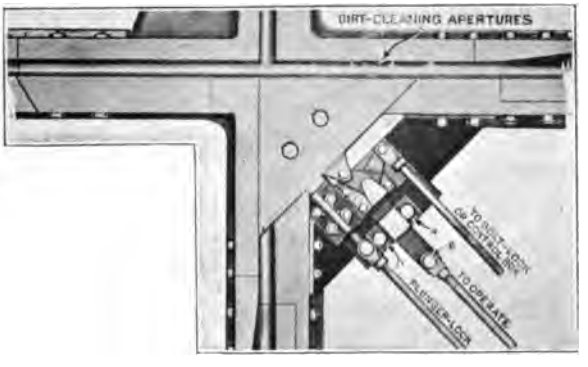
The crossing is operated either by an individual lever if available, or connected up with the derails, and operated and locked with them, without the addition of any extra equipment in the towers. Locking is effected either by switch and lock machines or standard plunger locks, staggered, insuring that the movable section of rail is securely locked in the proper position.

The principal feature of the Eymon Crossing is the four triangular movable blocks of manganese steel, which in the solid cast 4-piece Eymon crossing, move on a solid bed of manganese steel, unaffected by either contraction or expansion, because of its being entirely within the structure. The four blocks are designed to fit into the exterior angles of the crossing and so arranged by means of an easy double bend in the operating bar, that as it passes through a slot provided in the movable blocks, it serves to shift them sidewise in a direction at right angles with a line bisecting the angle of the block where it touches the crossing intersection.

The blocks are generally 2¼″ thick, of solid manganese, approximately 24″ on the running rail edge. The operating bars whose function is to move, guide and make interchangeable, the movable blocks, are ¼″ wide, 1″ thick, and about four feet long. The center of the

tracks is clear of any obstructions. Slotted apertures through the guardrail allow dirt, snow and other accumulations to be swept out at each movement of the movable blocks, thus providing a self-cleaning feature for the flangeways.

The reduced maintenance of the Eymon Crossing comprehends a saving in reballasting, surfacing, renewals of bolts and the routine operation of tightening bolts, as well as the expense of various crossing renewals, and affords



Operation and control of blocks of Eymon continuous crossing.

additional safety to the movement of traffic, as well as reduces the damage to rolling stock by eliminating the pound of the open flangeway. The length of service for the Eymon Crossing is apparently, the length of time to wear down uniformly, the heavy manganese rail. There are no special bolts or parts, all being standard track bolts and all parts interchangeable.

The Eymon Crossing may be installed as a unit in the same manner as any ordinary type of crossing. No special foundation is required for the solid cast manganese crossing, but it can be installed on the ordinary

timber or cross-tie foundation. All moving exposed parts have been eliminated from between the rails, avoiding the possibility of their being caught by dragging of cars.

The triangular movable blocks may be removed for inspection merely by removing two bolts. The absence of holes for the plunger lockpin within the block proper and the attachment of the slotted lug below the blocks, avoid reduction in the movable block section.

The Eymon Continuous Crossing increases safety of travel by providing a continuous rail instead of the two-inch flangeway the wheels must jump on an ordinary crossing. It materially decreases maintenance of track and rolling stock by eliminating the enormous shock which comes when every wheel, with its heavy load jumps the two inch gap in an ordinary crossing. It eliminates the deafening racket of the series of reports which wake up passengers on passing trains, as well as nearby residents.

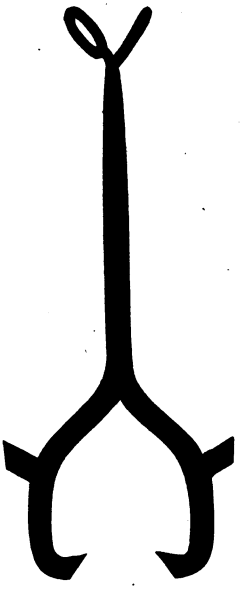
The Eymon Continuous Crossing is sold by the Eymon Continuous Crossing Company, Marion, Ohio.

TRANCO-DUPLEX TIE TONGS

Ever since the scarcity of tie timber began to be felt and the preservative treatment of ties began to attract attention, there has been a feeling that ties should be handled carefully, whether handled in material yards, unloading, or pulling them into the track, so that no holes may be left in them to collect moisture, which promotes decay.

Even from the standpoint of appearance, unsightly pick holes or shovel holes in ties are undesirable. Furthermore, the use of such tools (not being adapted to the work of handling ties) means that the ties are not being handled as cheaply nor as easily as they might be with tools de-

signed for the purpose. When using picks to drag ties into track it is frequently necessary for the track men to take several new holds because the pick slips out. This of course increases the number of holes left in the tie and in addition is dangerous because when the pick slips, the track man is likely to fall over backwards. If he is not injured, he is at least likely to work more carefully, and thus more slowly, in order not to injure himself. When carrying ties it is the practice of trackmen to knock the handles out of picks and then carry them, three men to a tie. This is an awkward process, as the man at the rear must raise the tie up before the pick handle can be placed under it by the two men at the front, and all of these extra motions take time. All of these objections to handling ties with picks and shovels apply alike to treated and untreated ties.



Tranco - Duplex Tie Tongs as Used for Pulling or Dragging Ties.

With the creosoted or chemically-treated ties, laborers object strenuously to handling them and getting the oil or chemical all over their hands and clothes. Then, too, the oiled ties are slippery and hard to handle in this manner. Naturally when doing disagreeable work of this kind the track men do not attempt to accomplish as much as when working under favorable conditions.

The Tranco-Duplex Tie Tong, illustrated herewith, is one of the simplest and most ingenious combination tools that has ever been designed for track work. By simply

turning the tongs over they are changed from pulling or dragging tongs into carrying tongs. They can be used by the track men for handling ties under any conditions which may arise. The points make hardly any impression in the ties, whether used in pulling or carrying. In addition to making the work easier, these tie tongs make it absolutely unnecessary for the laborer ever to touch either a treated or an untreated tie with his hands.

Tranco-Duplex Tie Tongs as Used for Carrying Ties.

When pulling ties into track there is no danger of the tie tongs slipping. When carrying ties the two laborers in front simply pick up the tie and no time is wasted in knocking a handle out of a pick or in getting the pick

handle under the tie. With one end dragging, as illustrated, two men can handle the tie just as well as three, so that one laborer is eliminated, in addition to the work being done much faster.

Tranco-Duplex Tie Tongs, used for both carrying ties and pulling them into track, are sold by the Track Necessities Company, Chicago.

TABLE 1.

TEMPERATURE EXPANSION FOR LAYING RAILS.*

The allowance that should be made for expansion for 33-ft. rails is shown in the following table.

The temperature should be taken on the rail, and the openings between the rail ends should be as follows:

Temperature (Fahrenheit)	Allowance
—20° to 0°	5/16 in.
0° to 25°	1/4 in.
25° to 50°	3/16 in.
50° to 75°	1/8 in.
75° to 100°	1/16 in.

Over 100 degrees rails should be laid close without bumping.

TABLE 2.

MIDDLE ORDINATES IN INCHES, FOR CURVING RAILS.

Degree of Curve	Length of Rail. 33 Ft.	30 Ft.	26 Ft.	20 Ft.	16 Ft.
3°	1	3/4	1/2	1/4	3/16
3°30′	1	7/8	5/8	3/8	1/4
4°	1 1/8	1	3/4	3/8	1/4
4° 30′	1 1/4	1	3/4	1/2	1/4
5°	1 3/8	1 1/8	7/8	1/2	3/16
5° 30′	1 5/8	1 1/4	1	1/2	3/8
6°	1 3/4	1 3/8	1	5/8	3/8
6° 30′	1 7/8	1 1/2	1 1/8	3/4	3/8
7°	2	1 5/8	1 1/4	3/4	1/2
7° 30′	2 1/8	1 3/4	1 3/8	3/4	1/2
8°	2 1/4	1 7/8	1 3/8	7/8	1/2
8° 30′	2 3/8	2	1 1/2	7/8	5/8
9°	2 1/2	2 1/8	1 5/8	1	5/8
9° 30′	2 3/4	2 1/4	1 3/4	1	5/8
10°	2 7/8	2 3/8	1 3/4	1 1/8	3/4
11°	3 1/8	2 5/8	1 7/8	1 1/4	3/4
12°	3 3/8	2 3/4	2 1/8	1 1/4	7/8
13°	3 3/4	3 1/4	2 1/4	1 3/8	7/8
14°	4	3	2 1/2	1 1/2	1
15°	4 1/4	3 1/2	2 5/8	1 1/2	1
16°	4 1/2	3 3/4	2 7/8	1 5/8	1 1/8
17°	4 7/8	4	3	1 3/4	1 1/4
18°	5 1/8	4 1/4	3 1/4	1 7/8	1 1/4
19°	5 3/8	4 1/2	3 3/8	2	1 1/4
20°	6	4 3/4	3 1/2	2 1/8	1 3/8

*American Railway Engineering Association.

TABLE 3.

WIDENING GAGE ON CURVES.

From The Manual of the A. R. E. Association.

Curves eight degrees and under should be standard gage. Gage should be widened one-eighth inch for each two degrees or fraction thereof over eight degrees, to a maximum of 4 ft. 9¼ in. for tracks of standard gage. Gage, including widening due to wear, should never exceed 4 ft. 9½ in.

The installation of frogs upon the inside of curves is to be avoided wherever practicable, but where same is unavoidable, the above rule should be modified in order to make the gage of the track at the frog standard.

The following table is made up from the above rule.

Degree	Increase Gage by	Correct Gage	Correct Distance Between Rail and Guard Rail
Up to 8 degrees	0 in.	4 ft. 8½ in.	1¾ in.
8 degrees			
9 degrees	⅛ in.	4 ft. 8⅝ in.	1⅞ in.
10 degrees			
11 degrees	¼ in.	4 ft. 8¾ in	2 in.
12 degrees			
13 degrees	⅜ in.	4 ft. 8⅞ in.	2⅛ in.
14 degrees			
15 degrees	½ in.	4 ft. 9 in.	2¼ in.
16 degrees			
17 degrees	⅝ in.	4 ft. 9⅛ in.	2⅜ in.
18 degrees			
19 degrees	¾ in.	4 ft. 9¼ in.	2½ in.
20 degrees			
20 degrees	⅞ in.	4 ft. 9⅜ in.	2⅝ in.
21 degrees			
22 degrees and above	1 in.	4 ft. 9½ in.	2¾ in.

TABLE 4.

SETS OF SWITCH TIES FOR VARIOUS TURNOUTS.

Frog No.	Space in Track	Split Switches No. of Tie of Each Length 15	8	9	10	11	12	13	14	Total Number
14	140′	2	12	10	14	12	10	8	6	74
12	120′	1	0	13	11	9	6	7	7	54
10	100′	2	9	14	8	7	7	4	4	55
8	75′	2	9	10	9	6	6	5	2	49
7	70′	2	9	8	6	6	5	4	2	42
6	60′	2	8	7	5	4	3	4	2	35
5	50′	2	6	6	3	3	2	4	2	28

TABLE 5.

SPACING OF CROSS TIES (SQUARE JOINTS)

Note—Joint ties assumed to be 9 in. from end of rail.

Length of Rail or Panel ft.	Spacing 12 ties per rail ft.	in.	Spacing 13 ties per rail ft.	in.	14 ties ft.	in.	15 ties ft.	in.	16 ties ft.	in.	17 ties ft.	in.	18 ties ft.	in.	19 ties ft.	in.	20 ties ft.	in.	Spacing 21 ties per rail ft.	in.
28	2	5	2	2½	2	0½	1	10¾	1	9¼										
29					2	1¼	1	11½	1	10	1	8½								
30					2	2¼	2	0¼	1	10¾	1	9¼	1	8	1	7				
31							2	1¼	1	11½	1	10	1	8¾	1	7¾				
32							2	2	2	0½	1	10¾	1	9½	1	8¼	1	7¼		
33									2	1¼	1	11½	1	10¼	1	9	1	7¾	1	6¾

TABLE 6.

NUMBER OF JOINTS, ANGLE BARS AND TIES PER MILE OF SINGLE TRACK

Length of Rail	No. of Rail Lengths Per Mile	No. of Pairs Angle Bars Per Mile	Number of Ties Spaced to Rail Length. 10	11	12	13	14	15	16	17	18	19	20	21
24 feet	220	440	2200	2420	2640	2860	3080	3300	.....	.....	.....	.....	.....	.....
25 feet	211.5	422	2115	2326	2538	2750	2961	3172	.....	.....	.....	.....	.....	.....
26 feet	203	406	.....	2233	2436	2640	2842	3045	3268	.....	.....	.....	.....	.....
27 feet	195.5	391	.....	2150	2346	2541	2737	2932	3128	.....	.....	.....	.....	.....
28 feet	188.5	377	.....	.....	2262	2450	2640	2827	3016	3204	.....	.....	.....	.....
29 feet	182.4	365	.....	.....	2189	2371	2554	2736	2918	3108	3283	.....	.....	.....
30 feet	176	352	.....	.....	2164	2356	2534	2640	2851	3009	3168	.....	.....	.....
31 feet	170.3	341	.....	.....	.....	2214	2384	2555	2725	2895	3065	3235	.....	.....
32 feet	165	330	.....	.....	.....	2145	2310	2475	2640	2805	2970	3135	3300	.....
33 feet	160	320	.....	.....	.....	2080	2240	2400	2560	2720	2880	3040	3200	3360

TABLE 7.

ORDINATES FOR LINING SWITCH LEADS.

1. Frog No.	2. Frog Angle	3. Distance Straight Track B.F. to P.S.	4. Radius of Outside Rail	5. Degree of Curve	6. Middle Ordinate	7. Quarter Ordinate	8. Change Middle Ordinate per Deg. Curve in Main Track	9. Change in Quarter Ordinate per Deg. Curve in Main Track
		ft. in.			in.	in.	in.	in.
5	11° 25′	52 6	220.1	26° 33′	9¾	7¼	3/8	¼
6	9° 32′	58 11	317.9	18° 14′	9¼	6⅞	½	3/8
7	8° 10′	65 1	437.5	13° 12′	8¾	6⅜	5/8	½
8	7° 09′	70 11	577.5	9° 58′	8¼	6⅛	¾	5/8
9	6° 22′	76 6	738.2	7° 48′	7¾	5¾	1	¾
10	5° 44′	81 9	924.0	6° 13′	7¼	5½	1⅛	⅞
11	5° 12′	87 1	1143.7	5° 01′	6¾	5⅛	1⅜	1
12	4° 46′	92 0	1388.0	4° 08′	6½	4¾	1½	1¼

Note—In Columns 6 and 7, ordinates are distances measured to gage side of rail from a string stretched from toe of frog to heel of switch point.

TABLE 8.

NUMBER OF TIES PER MILE WHEN EXPRESSED IN NUMBER PER 100 FEET.

No. of Ties in 100 Ft.	No. of Ties in 1 Mile	No. of Ties in 100 Ft.	No. of Ties in 1 Mile
40	2112	53	2798
41	2164	54	2851
42	2218	55	2904
43	2270	56	2957
44	2323	57	3009
45	2376	58	3062
46	2429	59	3115
47	2482	60	3168
48	2534	61	3220
49	2587	62	3274
50	2640	63	3326
51	2693	64	3379
52	2745	65	3332

TABLE 9.

ELEVATION OF OUTER RAIL IN INCHES.*

Degree of Curve	Velocity in Miles per Hour.													Degree of Curve
	10	15	20	25	30	35	40	45	50	55	60	65	70	
1	0	1/8	1/4	3/8	5/8	3/4	1 1/8	1 3/8	1 5/8	2	2 3/8	2 3/4	3 1/4	1
2	1/8	3/8	1/2	7/8	1 1/8	1 5/8	2 1/8	2 5/8	3 1/4	4	4 3/4	5 1/2	6 1/2	2
3	1/4	1/2	3/4	1 1/4	1 3/4	2 3/8	3 1/8	4	4 7/8	6	7 1/8	8 3/8	9 3/4	3
4	1/4	5/8	1	1 5/8	2 3/8	3 1/4	4 1/4	5 3/8	6 5/8	8	9 1/2	.....	.....	4
5	3/8	3/4	1 1/4	2	3	4	5 1/4	6 5/8	8 1/4	.....	.....	.....	.....	5
6	3/8	1	1 5/8	2 1/2	3 1/2	4 7/8	6 1/4	8	.....	.....	.....	.....	.....	6
7	1/2	1 1/8	1 7/8	2 7/8	4 1/8	5 5/8	7 3/8	.....	.....	.....	.....	.....	.....	7
8	1/2	1 1/4	2 1/8	3 1/4	4 3/4	6 1/2	8 3/8	.....	.....	.....	.....	.....	.....	8
9	5/8	1 3/8	2 3/8	3 3/4	5 3/8	7 1/4	.....	.....	.....	.....	.....	.....	.....	9
10	3/4	1 1/2	2 5/8	4 1/8	5 7/8	8 1/8	.....	.....	.....	.....	.....	.....	.....	10
11	3/4	1 3/4	2 7/8	4 1/2	6 1/2	8 7/8	.....	.....	.....	.....	.....	.....	.....	11
12	7/8	1 7/8	3 1/8	4 7/8	7 1/8	.....	.....	.....	.....	.....	.....	.....	.....	12
13	7/8	2	3 3/8	5 3/8	7 3/4	.....	.....	.....	.....	.....	.....	.....	.....	13
14	1	2 1/8	3 5/8	5 3/4	8 3/8	.....	.....	.....	.....	.....	.....	.....	.....	14
15	1	2 1/4	3 7/8	6 1/4	8 7/8	.....	.....	.....	.....	.....	.....	.....	.....	15
16	1 1/8	2 1/2	4 1/4	6 5/8	.....	.....	.....	.....	.....	.....	.....	.....	.....	16
17	1 1/4	2 5/8	4 1/2	7	.....	.....	.....	.....	.....	.....	.....	.....	.....	17
18	1 1/4	2 3/4	4 3/4	7 1/2	.....	.....	.....	.....	.....	.....	.....	.....	.....	18
19	1 3/8	2 7/8	5	7 3/4	.....	.....	.....	.....	.....	.....	.....	.....	.....	19
20	1 3/8	3	5 1/4	8 1/8	.....	.....	.....	.....	.....	.....	.....	.....	.....	20

In all cases gage is considered 4 ft. 8½ in.

Since the elevation required is a function of and depends upon the train speed, this speed is the first element to be determined.

In general, as a matter of safety, the preference should be given to fast passenger traffic.

Ordinarily an elevation of 8 in. should not be exceeded. Speed of trains should be regulated to conform to the maximum elevation used.

The elevation of curves should be zero at the point of spiral and should increase to full elevation at the end of the spiral or beginning of the simple curve.

The inner rail should be maintained at grade.

*American Railway Engineering Association.

TABLE 10.
SPACING OF CROSSTIES (BROKEN JOINTS).

Note—Joint ties assumed to be 9 in. from end of rail.

Length of Rail or Panel ft.	Spacing 12 ties per rail ft. in.	Spacing 14 ties per rail ft. in.	Spacing 16 ties per rail ft. in.	Spacing 18 ties per rail ft. in.	Spacing 20 ties per rail ft. in.	Spacing 22 ties per rail ft. in.
30		2 3	1 11	1 8¼	1 6	
31		2 4	2 0	1 9	1 6¾	
32		2 5	2 1	1 9¾	1 7½	1 5½
33		2 6	2 1¾	1 10½	1 8	1 6

TABLE 11.
DIMENSIONS OF RAILS.

Type	Weight per Yd.	Height	Base	Head
A. S. C. E.	100	5¾	5¾	2¾
A. S. C. E.	90	5⅜	5⅜	2⅝
A. S. C. E.	85	5¼	5¼	2½
A. S. C. E.	80	5	5	2½
A. S. C. E.	72	4¾	4¾	2⅜
A. S. C. E.	70	4⅝	4⅝	2½
A. S. C. E.	65	4½	4½	2⅜
A. S. C. E.	60	4¼	4¼	2⅜
A. R. A.-A	100	6	5½	2¾
A. R. A.-A	90	5⅝	5⅛	2⅛
A. R. A.-A	80	5⅛	4⅝	2½
A. R. A.-A	70	4¾	4¼	2⅜
A. R. A.-A	60	4½	4	2¼
A. R. A.-B	100	5⅝	5⅛	2⅝
A. R. A.-B	90	5¼	4¾	2½
A. R. A.-B	80	4⅞	4⅛	2½
A. R. A.-B	70	4½	4⅛	2⅜
A. R. A.-B	60	4⅛	3⅝	2⅛

TABLE 12.
CUBIC YARDS OF BALLAST REQUIRED FOR VARIOUS DEPTHS BELOW TOP OF TIE.

Top Width	Cubic Yds. per 100 ft.				Cubic Yds. per Mile			
Single Track	Depth Below Top of Tie 9 in.	12 in.	15 in.	18 in.	Depth Below Top of Tie 9 in.	12 in.	15 in.	18 in.
10	22¼	33⅛	44½	56¼	1177	1739	2370	2980
11	25	36⅞	49⅛	61⅞	1342	1947	2600	3270
12	27¾	40½	53¾	67⅜	1468	2143	2840	3650
Double Track								
22	48	70	96⅛	115⅜	2540	3700	5080	6100
23	50¾	73⅝	100¾	120⅞	2680	3900	5320	6390
24	52¾	77	104	124⅛	2780	4060	5490	6550

Table 13.

REQUIREMENTS FOR ONE MILE OF TRACK.

Tie Centers	No. Ties per Mile	No. Tie Plates per Mile	Four Spikes to Tie	Six Spikes to Tie	L'gth Rail	No. Rails per Mile	No. Splices per Mile	No. Bolts per Mile		Fence Posts	
								Four Hole Splice	Six Hole Splice	Foot Apart	No. One Side
24 in.	2640	5280	10560	15840	20 ft.	528	1056	2112	3168	8 ft.	660
23 in.	2755	5510	11020	16530	22 ft.	480	960	1920	2880	12 ft.	440
22 in.	2880	5760	11520	17280	24 ft.	440	880	1760	2640	14 ft.	377
21 in.	3017	6034	12068	18102	26 ft.	407	814	1628	2442	16 ft	330
20 in.	3168	6336	12672	19008	28 ft.	378	756	1512	2268	16½ ft.	320
19 in.	3335	6670	13340	20010	30 ft.	364	728	1456	2184	18 ft.	293
18 in.	3520	7040	14080	21120	33 ft.	326	652	1304	1956	19 ft.	278

Figures for 33 ft. and 30 ft. rails, splices and bolts based on ten per cent shorts in rails down to 24 ft.

Table 14.

Amount in Gross Tons of Rails for 1 mi. of Track.

Weight Per Yd.	Tons Per Mi.
50 lbs.	78⅝
56 lbs.	88
65 lbs.	102⅛
70 lbs.	110
72 lbs.	113⅛
75 lbs.	117⅞
80 lbs.	125¾
85 lbs.	133⅝
90 lbs.	141½
95 lbs.	149⅜
100 lbs.	157⅛
105 lbs.	165
110 lbs.	172⅞

Tables showing (1) Frog-board with dimensions for various frogs; (2) Distances between frog-points on ladders; (3) Lengths of practical switch leads; (4) Distances between crossover frog points; (5) Ladder layout table; (6) Degree of turnout curve with frog on inside of curve; and (7) Degree of turnout curve with frog on outside of curve. are given in Practical Track Work, a book dealing exclusively with track and switch construction.

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